# OAK RIDGE RESERVATION

# RISK-BASED END STATE VISION

# (Revision D1)


**U.S. Department of Energy**
**Oak Ridge Operations Office**
**Oak Ridge, Tennessee**

DRAFT: February 1, 2004

# DOE Oak Ridge Reservation
# Risk-Based End State Vision
# (Revision D1 - February 1, 2004)
# Summary of Changes from October 31, 2003 D0 Draft

This document has been extensively revised in response to review comments from DOE-HQ and other reviewers, such that highlighting changes within the text of the document using a "redline/strikeout" approach is not practicable. Major changes include the following:

- Maps are currently being developed to comply with format and content requirements specified in Appendix B of the *Guidance for Developing a Site-Specific Risk-Based End State Vision* (DOE 2003). You will note that these maps are not included within the current submittal, but their points of insertion are indicated by otherwise blank pages with the corresponding Figure number and title. We regret the delay in providing these maps, but this task has required contractual modifications which have proven to be very time-consuming. We plan to issue another interim draft, including all maps, as soon as possible and prior to the submittal of the final document.

- Conceptual site models have been revised to meet the format and content requirements specified in Appendix C of the above-referenced guidance document. (We note, however, that the prescribed format appears to be completely consistent with neither ASTM guidance nor the EPA Risk Assessment Guidance for Superfund (RAGS) guidance normally used for development of CSMs for DOE-ORO CERCLA activities.)

- A Variance Analysis has been developed to meet the guidelines specified in Appendix D of the guidance document and is included as Appendix A of this revised draft.

- The text of the document has been extensively revised to provide additional information throughout the document. In particular, Section 4, Hazard Specific Discussion, has been revised to include summary level information on the hazards, contaminants of concern, and estimated risks to human health and ecological receptors for each hazard area; and to more fully describe the status of remedial action planning and implementation for each hazard area. For each hazard area, the current status, current baseline plan, and RBES vision are now explicitly described and compared.

- We have also attempted to address all specific comments received from DOE-HQ and from DOE-ORO stakeholders in the revised draft.

We hope that these revisions will help to clarify the risk-based end state vision for the DOE Oak Ridge Reservation. We continue to feel that existing CERCLA decisions made to date and the current baseline plan for ongoing and future cleanup actions at the Oak Ridge Reservation are already risk-based and fully consider the planned end use of each site; therefore, the baseline plan is already very closely aligned with the risk-based end state vision. Only a few possible exceptions have been identified to date, and these are described in the variance analysis.

## EXECUTIVE SUMMARY

This document describes the Risk-Based End State (RBES) Vision for the U.S. Department of Energy (DOE) Oak Ridge Reservation (ORR) in Oak Ridge, Tennessee, in support of DOE Policy 455.1, "Use of Risk-Based End States", and the associated guidance document. The risk-based end state represents site conditions that reflect the planned future use of the property at the completion of the EM mission and is appropriately protective of human health and the environment consistent with that land use. The intent of this policy is to ensure that cleanup efforts throughout the DOE complex are driven by clearly defined, risk-based end states and to identify any potential variances between current cleanup plans and actions required to attain the risk-based end state.

The DOE Oak Ridge Reservation encompasses approximately 35,000 acres in Anderson and Roane Counties in eastern Tennessee. The ORR is bordered by City of Oak Ridge to the north and east, and the Clinch River to the south and west. Land use in the surrounding area includes residential, commercial and agricultural properties; other than the city of Oak Ridge, property immediately adjacent to the ORR is primarily rural.

The three primary DOE installations located within the ORR are the East Tennessee Technology Park (ETTP), Oak Ridge National Laboratory (ORNL), and the Y-12 National Security Complex (Y-12). Operations at these facilities dating from the Manhattan Project in 1942 have resulted in contamination of the environment, leading to the listing of the entire ORR by the Environmental Protection Agency (EPA) on the National Priorities List in 1989. The DOE Environmental Management (EM) Program is responsible for environmental restoration of contaminated sites within the ORR. In 2002, DOE adopted a plan to accelerate completion of the EM mission for the ORR, with remediation of the highest risk sites by 2006 and completion of the overall EM scope by 2015.

Each of the major facilities that comprise the DOE Oak Ridge Reservation has a different expected end use. The East Tennessee Technology Park has no continuing DOE mission and will be remediated to allow use as a commercial industrial park without a significant DOE presence. Oak Ridge National Laboratory will continue to be operated by the DOE Office of Science (DOE-SC) as a multi-disciplinary research and development center (UT-Battelle 2002). The Y-12 National Security Complex will continue to be operated by the National Nuclear Security Administration (NNSA) for national defense operations (BWXT 2003).

In order to facilitate and streamline remedial decision-making, the contaminated areas of the Oak Ridge Reservation have been divided into the following six areas roughly equivalent to the major hydrologic watersheds:

- East Tennessee Technology Park
- Melton Valley at the Oak Ridge National Laboratory
- Bethel Valley at the Oak Ridge National Laboratory
- Upper East Fork Poplar Creek at the Y-12 National Security Complex
- Bear Creek Valley at the Y-12 National Security Complex
- Chestnut Ridge at the Y-12 National Security Complex

Remedial actions for the ORR are regulated under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), and a Federal Facility Agreement approved by DOE, EPA, and the Tennessee Department of Environment and Conservation (TDEC) in 1992. Numerous remedial actions have been conducted for contamination sites throughout the ORR. In recent years, remediation decisions have evolved from narrowly focused actions designed to address individual contamination sites to watershed-scale decisions designed to best address the cumulative impacts of multiple contamination sites within a watershed. The resultant watershed decision-making allows a decision on the end state to be made in concert with the decision on the series of remedial actions needed to protection of human health and the environment for that end state. By considering the technical practicability and cost of achieving a range of end states, the decision-makers can make informed risk-based decisions consistent with the anticipated end use.

In order to gain a better understanding of community values and desired future uses for contaminated areas on the Oak Ridge Reservation, DOE asked the Oak Ridge Reservation Environmental Management Site Specific Advisory Board (SSAB) to develop:

- recommendations for end uses of contaminated areas on the Oak Ridge Reservation
- community values that could be used to guide DOE's remedial action decision-making process.

The End Use Working Group was formed in January 1997 to develop these recommendations. The End Use Working Group was composed of individuals with a broad range of public interests and included participation by TDEC and EPA. They considered the contaminants, the contaminant pathways, a range of end uses, and the cost and technical implications of achieving various end uses. In July 1998 the End Use Working Group published its recommendations to DOE on end uses for contaminated lands and on community values.

Subsequent to these recommendations, watershed records of decision (RODs) have been approved under CERCLA for Melton Valley, Bethel Valley, Bear Creek Valley, part of Upper East Fork Poplar Creek, and part of the East Tennessee Technology Park; and decisions are underway for the remainder of the East Tennessee Technology Park and Upper East Fork Poplar Creek. In each case, the remedial actions have been designed to support the desired end use for that property. Additional CERCLA decision documents are planned for Chestnut Ridge and for additional actions in Bear Creek Valley. The watershed-level RODs issued to date are considered interim decisions, designed to address specific contaminant source areas and mitigate the potential for release of contaminants. Site-wide response actions for groundwater protection and long-term institutional controls have been deferred to future decisions.

The current life-cycle baseline has been developed to support the end uses contained in the records of decision where available and on the recommendations of the End Use Working Group for those areas for which decisions have not been made. The assumed end uses in the life-cycle baseline include:

East Tennessee Technology Park – Unrestricted industrial use (commercial industrial park)

Melton Valley – Some restricted waste management areas, some DOE-controlled industrial use

Bethel Valley – Some DOE-controlled industrial use, some unrestricted industrial use

- Upper East Fork Poplar Creek – DOE/NNSA-controlled industrial use

  Bear Creek Valley – DOE/NNSA-controlled industrial use (with some restricted waste management areas)

- Chestnut Ridge – DOE/NSSA-controlled industrial use (with some restricted waste management areas)

Cleanup decisions made to date for the ORR and the current life-cycle baseline plan are generally consistent with the risk-based end state vision. The end use recommended for each area by the End Use Working Group have been carefully considered and integrated in the CERCLA decision process, and risk management decisions have been developed through a broad-based effort that considered the technical and financial implications of achieving a range of potential end uses. Remedial action objectives are designed to achieve adequate protection of human health and the environment under the planned end use conditions. Remediation decisions made to date and this risk-based end state vision document also have been developed in consideration of the respective long-term planning documents for each site with an ongoing mission [e.g., currently including the *Oak Ridge National Laboratory Land and Facilities Plan* (UT-Battelle 2002) and the *Y-12 National Security Complex Ten-Year Comprehensive Site Plan* (BWXT 2003)].

Following completion of the EM mission in 2015, the primary hazards remaining at the Oak Ridge Reservation are expected to consist primarily of the areas dedicated to long-term management of radioactive and hazardous waste. These include capped waste disposal sites in Melton Valley, the Environmental Management Waste Management Facility (EMWMF) and the Bear Creek Burial Ground (BCBG) in Bear Creek Valley, and capped waste disposal sites on Chestnut Ridge and other locations. Additional hazards may include contaminated sediments in White Oak Creek and White Oak Lake in Melton Valley and miscellaneous smaller hazard areas. Potential risks from each of these hazards will be managed primarily through the use of institutional controls to restrict access to these areas and ongoing monitoring.

A variance analysis is presented in this document to identify situations where the currently planned remedial actions may exceed what might be required to attain the risk-based end state. Such variances occur because criteria other than risk (e.g., cost, reliability, permanence, stakeholder preferences) are also involved in the remedy selection process prescribed under CERCLA. In most cases, the variances identified here constitute relatively minor deviations from the current baseline plans, as the great majority of completed and planned remedial actions at the ORR facilities already have been developed specifically to manage risks to future receptors to acceptable levels based on the planned end use for each site.

Robust community participation has been a key element in the remedy selection process for the Oak Ridge Reservation sites to date. Comments on the initial draft of the RBES vision document have been received to date from the State of Tennessee and the Citizens' Advisory Panel of the Oak Ridge Reservation Local Oversight Committee (CAP-LOC). The Tennessee Department of Environment and Conservation indicated general agreement with the use of a risk-based end state approach, but expressed concerns regarding long-term institutional controls: that risk-based cleanup decisions should be selected to minimize the need for long-term controls; and, where this is not possible, a mechanism for assured long-term funding should be in place. Similar concerns also were expressed in the Citizens' Advisory Panel comments. In addition, the CAP-LOC comments also objected to deviations from the 1998 recommendations of the End Use Working Group for the Upper East Fork Poplar Creek and Bear Creek Valley watersheds; these issues are discussed in this revised draft document.

***[NOTE: Please note that development of maps specified in the RBES guidance document (DOE 2003b) has been delayed due to contractual issues, such that these maps are not included in this draft document. As a result, there are numerous blank pages in this document which indicate where these figures will be inserted when they become available. A subsequent revision of this document will be distributed as soon as these maps are completed.]***

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# ACRONYMS

| | |
|---|---|
| ALARA | as low as reasonably achievable |
| ARAR | applicable or relevant and appropriate requirement |
| AWQC | ambient water quality criteria |
| BCBG | Bear Creek Burial Grounds |
| BYBY | Boneyard/Burnyard |
| CAP | Citizens' Advisory Panel |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act of 1980 |
| CFR | *Code of Federal Regulations* |
| COC | constituents of concern |
| CROET | Community Reuse Organization of East Tennessee |
| DARA | Disposal Area Remedial Action |
| DNAPL | dense nonaqueous-phase liquid |
| DOE | U.S. Department of Energy |
| ELCR | excess lifetime cancer risk |
| EMWMF | Environmental Management waste management facility |
| EPA | U.S. Environmental Protection Agency |
| ESD | Explanation of Significant Differences |
| ETTP | East Tennessee Technology Park |
| EUWG | End Use Working Group |
| FFA | Federal Facility Agreement |
| FS | feasibility study |
| HI | Hazard Index |
| HQ | Hazard Quotient |
| LOC | Oak Ridge Reservation Local Oversight Committee, Inc. |
| MCL | maximum contaminant level |
| NCP | National Oil and Hazardous Substances Pollution Contingency Plan |
| NNSA | National Nuclear Security Administration |
| NEPA | National Environmental Policy Act of 1969 |
| ORNL | Oak Ridge National Laboratory |
| ORO | Oak Ridge Operations Office |
| ORR | Oak Ridge Reservation |
| PCB | polychlorinated biphenyl |
| ppm | parts per million |
| ppt | parts per trillion |
| RAO | remedial action objective |
| RCRA | Resource Conservation and Recovery Act of 1976 |
| RI | remedial investigation |
| ROD | record of decision |
| SSAB | Site-Specific Advisory Board |
| TDEC | Tennessee Department of Environment and Conservation |
| UEFPC | Upper East Fork Poplar Creek |
| VOC | volatile organic compound |
| WAG | waste area grouping |

# 1.0 INTRODUCTION

The U.S. Department of Energy (DOE) Oak Ridge Operations Office (ORO) has developed this document in support of DOE Policy 455.1, *Use of Risk-Based End States* (DOE 2003a), and in accordance with the associated guidance document, *Guidance for Developing a Site-Specific Risk-Based End State Vision* (DOE 2003b). DOE P 455.1 was issued in July 2003, in response to the DOE Top-to-Bottom Review (DOE 2002). Its purpose is to improve the effectiveness of cleanup actions throughout the DOE complex by focusing on achieving clearly defined, risk-based end states which integrate both risk and future land use considerations.

Risk-based end states are representations of site conditions and associated information that reflect the planned future use of the property and are appropriately protective of human health and the environment consistent with that use. The policy and guidance manual require each DOE site to prepare a Risk-Based End State Vision document that communicates the risk-based end state to involved parties, including regulators and the public. Under this policy, once the sites have developed their site-specific risk-based end state vision, they are directed to re-evaluate their current cleanup activities and strategies to determine if it is appropriate to change site baseline documents and renegotiate agreements. Sites would then work with their regulators to modify, as needed, their cleanup strategies, cleanup agreements and baselines, and then update their cleanup baselines and performance plans accordingly to better reflect the risk-based end state vision of the site.

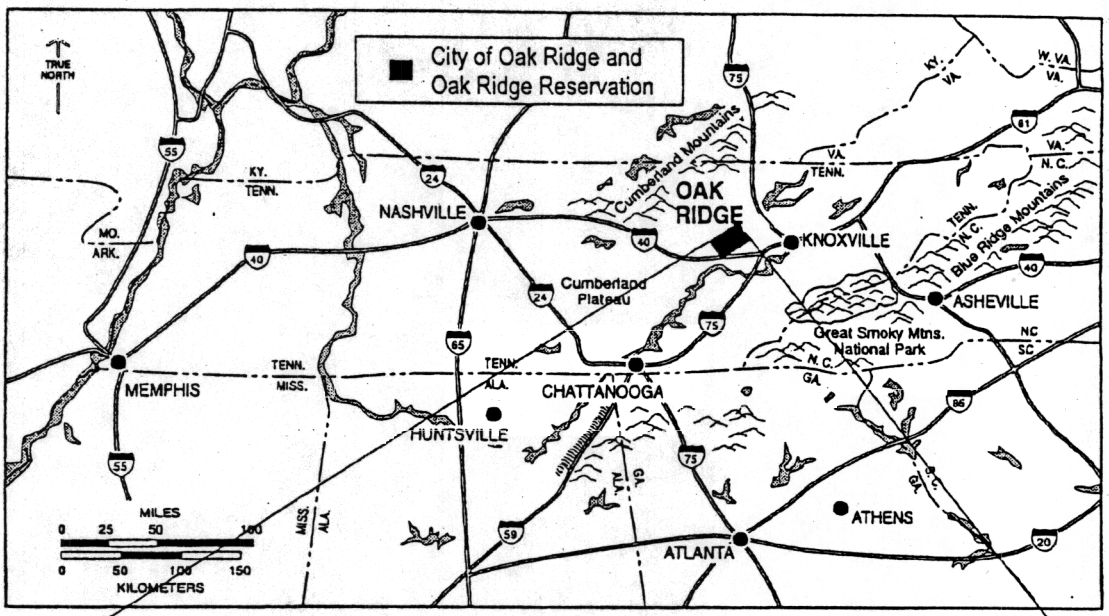
## 1.1 Organization of Report

This document is organized to meet the requirements of the *Guidance for Developing a Site-Specific Risk-Based End State Vision* (DOE 2003b). The DOE mission for the Oak Ridge Reservation is discussed in Section 1.2 and the current status of the cleanup program is summarized in Section 1.3. Section 2 describes the current state and RBES conditions at the ORR at the regional level, with respect to physical and surface features and human and ecological land use. Section 3 presents a similar discussion at the site-specific level. Section 4.0 describes each of the hazard areas for the ORR under current state and RBES conditions, including conceptual site models. A variance analysis is presented in Appendix A.

## 1.2 Site Mission

In 1942, approximately 35,000 acres were acquired in Anderson and Roane Counties in east Tennessee (see Figure 1.0) to build facilities for large-scale production of fissionable material for the world's first nuclear weapons. In 1943, construction began on the X-10 nuclear research facility [now known as the Oak Ridge National Laboratory (ORNL)], the first uranium enrichment facility (now known as the Y-12 National Security Complex), and a gaseous diffusion enrichment facility [the K-25 Plant, currently called the East Tennessee Technology Park (ETTP)]. Since that time, the missions of these facilities have evolved as described below:

SOURCE: ORNL-DWG 94M-8368R2




SOURCE: ORNL-DWG 93M-9616R2

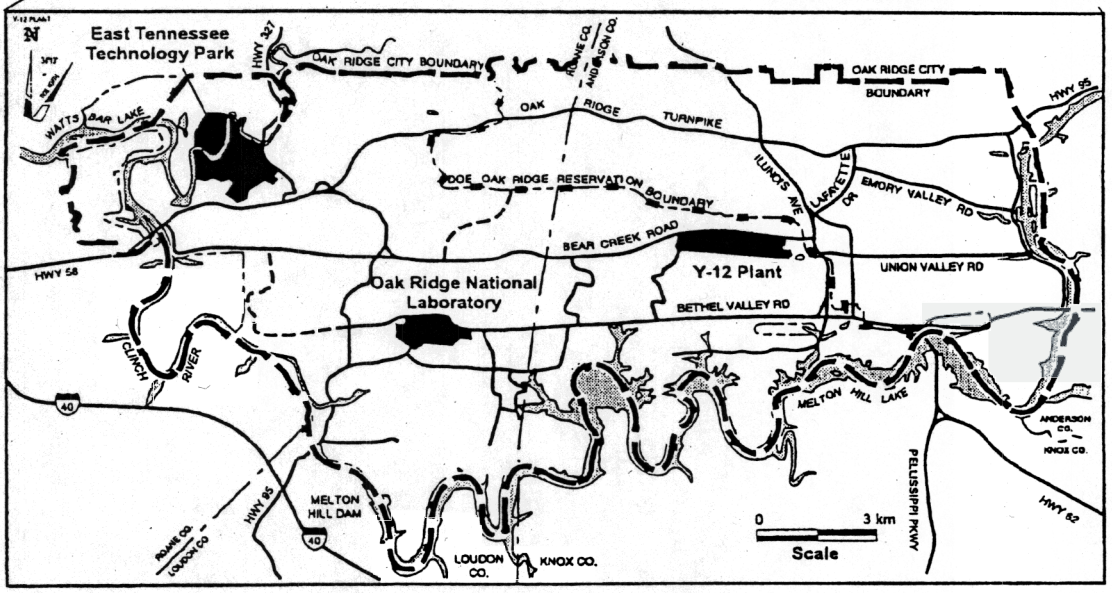



**Fig. 1.0**

**Location of Oak Ridge Reservation**

DOE - ORNL Melton Valley watershed - Oak Ridge, Tennessee

| DOCUMENT ID: 35H830 0089-20/ROD | DRAWING ID: 99-16983.CDR | DRAWING DATE: February 24, 2000 SB |
|---|---|---|

**ORNL** - The Oak Ridge National Laboratory was built in 1943 to produce and chemically separate the first gram quantities of plutonium as part of the national effort to produce the atomic bomb. As its role in the development of nuclear weapons decreased, the work at ORNL expanded to include fuel processing research; production of radioisotopes; construction and operation of various nuclear reactor designs; fundamental research in a variety of sciences; research involving hazardous and radioactive materials; environmental research; and radioactive waste disposal. ORNL has become DOE's largest multi-program research and development laboratory and is currently embarking on a major revitalization program.

The primary cleanup challenges at ORNL include elevated concentrations of cesium, strontium, and tritium in surface water and sediment; five shutdown reactors requiring demolition; 140 acres of burial grounds; waste seepage pits, trenches, tanks, and impoundments containing high activity wastes; 2 million curies of radioactivity in a water-rich environment and migrating to the Clinch River; cleanup of soils and demolition of facilities in an operating laboratory environment; and over 6,000 $yd^3$ of legacy waste to be disposed. The two major watersheds within the ORNL site are addressed separately for purposes of remediation. Bethel Valley includes the main industrial complex of ORNL, while Melton Valley includes most of the waste burial grounds.

- **ETTP** - ETTP, formerly the Oak Ridge Gaseous Diffusion Plant (K-25), was built during World War II to supply enriched uranium for nuclear weapons production. The EM Program became the landlord for the site after the facility was placed in "ready standby" mode in 1985 and operations were permanently shut down in 1987. In 1990, the mission became the demonstration and development of technology for environmental restoration, waste management, and decontamination and decommissioning. In 1997, the site was renamed ETTP to reflect the new mission to reindustrialize the site's infrastructure for use by the private sector. There is no continuing DOE mission at ETTP.

  Degrading, contaminated, 50-year-old gaseous diffusion and support buildings are the principal threat at ETTP. Unstable structures, roof integrity failures, intense rainfall events, and other natural phenomena increase the risk of uncontrolled releases of uranium and other contaminants to Poplar Creek, which feeds the Clinch River. Coupled with these risks are the burdensome "mortgage costs," e.g., utilities, security, surveillance and maintenance, and fire protection, required to maintain the site in a stable configuration. In addition, approximately 27,000 $yd^3$ of low-level waste must be disposed. For purposes of remediation, ETTP is being addressed in three distinct components: remediation of soils in Zone 1 (property outside the main industrial complex), remediation of soils and structures in Zone 2 (the main industrial complex), and remediation of site-wide groundwater.

  **Y-12** - Built in 1943, the original purpose of the Y-12 National Security Complex (Y-12) was uranium enrichment and nuclear weapons production. Uranium enrichment using the electromagnetic separation process was discontinued in 1947, but other aspects of

weapons production continued until 1993. Y-12's role has evolved into providing capabilities for highly sophisticated manufacturing; producing, fabricating, and dismantling nuclear weapons components; stockpile stewardship for enriched uranium and lithium materials; drawdown and disposition of special nuclear materials; and other complimentary missions. The Y-12 National Security Complex is currently embarking on a modernization program.

The primary cleanup challenges at Y-12 include elevated levels of mercury in soil, sediment, and surface water; offsite migration of volatile organic compounds in groundwater; uranium burial grounds; roughly 9,000 $yd^3$ of low-level waste to be disposed; and contaminated buildings with no further use for national defense. For purposes of remediation, the Y-12 site is subdivided into three distinct watersheds: Upper East Fork Poplar Creek, which includes the main industrial complex; Bear Creek Valley, which is located to the west of the main industrial complex and contains most of the major waste disposal areas at Y-12; and Chestnut Ridge, which is located to the south of the main industrial complex and includes several waste disposal areas.

These production and research activities have left a legacy of contaminated sites and facilities requiring cleanup. Radioactive and hazardous materials from burial grounds, ponds, seepage pits and trenches, tanks, underground pipelines, and surplus facilities have contaminated soils, groundwater, and surface water. Major contaminants include strontium, cesium, tritium, uranium, mercury, polychlorinated biphenyls (PCBs), and volatile organic chemicals (VOCs).

## 1.3 Status of Cleanup Program

The Environmental Protection Agency (EPA) placed the Oak Ridge Reservation on the National Priorities List in 1989. Consequently, remedial actions for the ORR are regulated under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). A Federal Facility Agreement was approved by DOE, EPA, and the Tennessee Department of Environment and Conservation (TDEC) in 1992. Numerous remedial actions have been conducted for contamination sites throughout the ORR through a variety of decision documents, including Action Memoranda, Records of Decision, and Interim Records of Decision. In addition, numerous closure actions have been conducted under the Resource Conservation and Recovery Act (RCRA).

In recent years, remediation decisions have evolved from narrowly focused actions designed to address individual contamination sites to watershed-scale decisions designed to best address the cumulative impacts of multiple contamination sites within a watershed. In order to facilitate and streamline remedial decision-making, the contaminated areas of the ORR have been divided into the following six areas (Figure 1.1) roughly equivalent to the major hydrologic watersheds:

- East Tennessee Technology Park
- Melton Valley at the Oak Ridge National Laboratory
- Bethel Valley at the Oak Ridge National Laboratory
- Upper East Fork Poplar Creek at the Y-12 National Security Complex
  Bear Creek Valley at the Y-12 National Security Complex

- Chestnut Ridge at the Y-12 National Security Complex

In 1996, prior to any watershed decisions, DOE issued a draft proposal on its preferred remediation method for four surface impoundments at ORNL. This proposal included the creation of a consolidated disposal cell within the area of the surface impoundments. However, the State of Tennessee favored an alternative proposal involving complete excavation of the impoundments with disposal of contaminated material off the ORNL site. The State also believed that DOE's remediation decisions lacked community involvement. Subsequently, the State recommended that any remediation decision for the surface impoundments should include broad-based public involvement.

In response to the State's recommendation, DOE asked the Oak Ridge Reservation Environmental Management Site Specific Advisory Board (SSAB) to initiate a process to gain a better understanding of community values and desired future uses for contaminated areas on the Oak Ridge Reservation. The DOE asked the SSAB to develop:

- recommendations for end uses of contaminated areas on the Oak Ridge Reservation
- community values that could be used to guide DOE's remedial action decision-making process.

The SSAB determined that a broad, independent group was needed for such an effort. In January 1997 the SSAB sponsored a public meeting to seek volunteers for the End Use Working Group (EUWG). More than 100 attendees discussed the issues and process of the EUWG. As a result, more than 20 individuals initially participated as EUWG members, while a similar number requested to be kept informed by receiving EUWG materials. EUWG membership was diverse and included members from most area stakeholder organizations, including the Oak Ridge Environmental Peace Alliance, both the Citizens' Advisory Panel and the Board of the Oak Ridge Reservation Local Oversight Committee, the Oak Ridge Reservation Environmental Management Site Specific Advisory Board, Friends of Oak Ridge National Laboratory, Oak Ridge Environmental Quality Advisory Board, League of Women Voters, and Coalition For a Healthy Environment. Oak Ridge City government also participated through members of the Oak Ridge City Council and the Oak Ridge Regional Planning Commission. Participation by individuals with different perspectives enhanced the quality of discussions and the development and evaluation of alternative end uses for contaminated areas within each watershed. The EUWG also coordinated with EPA Region 4 and TDEC staff to ensure that activities were serving the regulators' environmental decision-making expectations.

The EUWG discussed the contaminants and contaminant transport in each watershed, considered a range of differing end uses, and evaluated the cost and technical implications of achieving the differing end uses. In July 1998 the EUWG published its recommendations (EUWG 1998) to DOE on end uses for contaminated lands and on community values.

Subsequent to these recommendations, watershed records of decisions have been issued under CERCLA for Melton Valley, Bethel Valley, Bear Creek Valley, part of Upper East Fork Poplar Creek, and part of the East Tennessee Technology Park; and decisions are underway for the remainder of the East Tennessee Technology Park and Upper East Fork Poplar Creek.

Additional CERCLA decision documents are planned for Chestnut Ridge and for additional actions in Bear Creek Valley. The watershed-level RODs developed to date are considered interim decisions, designed to address specific contaminant source areas and mitigate the potential for release of contaminants. Site-wide response actions for groundwater protection and long-term institutional controls have been deferred to future decisions. Planned remedial actions for each of these watersheds are briefly summarized in the remainder of this section and discussed in greater detail in Section 4.

In August 2002, DOE adopted the *Oak Ridge Performance Management Plan* (PMP) to achieve accelerated completion of the EM mission for the ORR, by implementing the recommendations of the *Top to Bottom Review* issued by the DOE Assistant Secretary for Environmental Management in February 2002. This cleanup strategy is a risk-based approach that focuses first on those contaminant sources that are the greatest contributors to risk. The overall strategy is based on surface water considerations, encompassing the watersheds that are impacted by the DOE industrial sites and feed the Clinch River. While risk reduction is the major cleanup driver, other factors that must be considered to achieve risk reduction are execution logic and mortgage reduction. The reduction of mortgage costs provides a dramatic benefit due to the reinvestment of these saved funds into accelerated risk reduction and reduces amount and duration of funding needed from the Cleanup Reform Account. The plan also includes a number of substantive changes to work practices designed to facilitate work execution.

The PMP is based on the following land use assumptions, which are consistent with the recommendations of the EUWG and CERCLA decisions made to date as well as the long-range planning documents for those sites with an ongoing mission [specifically including the *Oak Ridge National Laboratory Land and Facilities Plan* (UT-Battelle 2002) and the *Y-12 National Security Complex Ten-Year Comprehensive Site Plan* (BWXT 2003)]:

- **ORNL** will continue to operate as a world-class research facility. The EM mission is to reduce remaining risks and complete cleanup as quickly and safely as possible.
  **Y-12** will continue to operate, fulfilling its national security mission. The EM mission is to reduce remaining risks and complete cleanup as quickly and safely as possible.
- **ETTP** will be available for use as a private-sector industrial park.

Under the PMP, completion of the EM mission will be accomplished using a phased approach. The following projects with the greatest potential for risk reduction and/or mortgage reduction will be completed by 2008:

- **Melton Valley: Completion by 2006** – The Melton Valley actions have been widely reviewed and accepted by the public through the CERCLA process and a signed interim record of decision is in place. The Melton Valley burial grounds pose the highest risks on the ORR, and therefore this project provides the opportunity for early and significant risk reduction. Completion actions include: hydraulic isolation through installation of multi-layer caps; removal, treatment, and disposal of retrievable transuranic (TRU) waste; soil and sediment excavation and disposal; demolition of facilities without identified future use; in-situ grouting; plugging and abandonment of wells; and disposition of spent nuclear fuel and legacy waste.

**ETTP: Closure by 2008** – ETTP consists of hundreds of facilities, including 50-year-old gaseous diffusion process buildings and other site infrastructure, that require nearly $60 million per year in landlord costs. Therefore, this project provides the greatest opportunity for significant mortgage reduction which frees funding to be applied to further risk reduction. Closure actions include: demolition of all facilities without identified future use by private industry; off-site disposition of uranium hexafluoride ($UF_6$) cylinders; excavation of burial grounds and highly contaminated soils; completion of groundwater contamination actions in accordance with the CERCLA process; and disposition of legacy waste.

- **Y-12** – Specific high risk reduction actions at Y-12 include mitigation of off-site releases of mercury in surface water; bioremediation of an off-site volatile organic compound (VOC) groundwater plume; and, excavation of uranium hot spots and hydraulic isolation of other contaminant sources.

- **Bethel Valley at ORNL** – Specific high risk reduction actions at Bethel Valley include completion of an engineering evaluation to identify further sources of groundwater contamination; completion of the Corehole 8 removal action; excavation of highly contaminated sediment from surface impoundments in the center of ORNL (completed in 2003); and removal of the Molten Salt Reactor Experiment fuel salts.

**Offsite Areas** – DOE-ORO also has responsibility for remediation of several off-site, non-DOE-owned properties, the David Witherspoon 901 and 1630 sites in Knoxville, Tennessee, and the Atomic City Auto Parts site in Oak Ridge. Planned actions at these sites include removal of contaminated structures, debris, soil, and sediment for disposal at the EMWMF.

**Accelerate Disposition of All Legacy Waste** – All legacy waste will be dispositioned by 2005 with priority given to those waste streams in Melton Valley and ETTP that are on the critical path for completion of those projects. A key element to accelerating the disposition of legacy low-level waste is onsite disposal in EMWMF for nearly 60% of the legacy low-level waste inventory that is stored outdoors at ETTP.

- **Accelerate Transfer of Newly Generated Waste Responsibility** – All facilities and systems that the EM Program currently operates to manage waste actively generated by the National Nuclear Security Administration and the Office of Science will be returned to those programs. EM funds will be used only to address EM legacy and remediation waste.

Following completion of these initial actions by 2008, additional actions to accomplish further risk reduction and completion of the EM mission will be completed by 2015:

- **Y-12** – Planned actions include the demolition of the Alpha 4 facility, two recently transitioned facilities, and remaining waste management facilities; remediation of mercury- and PCB-contaminated soil and sediment; hydraulic isolation of subsurface

mercury contamination beneath facilities in the West End Mercury Area; removal and disposal or closure-in-place of materials at Chestnut Ridge; and, hydraulic isolation of remaining buried materials in Bear Creek Valley.

- **ORNL** – Planned actions include the demolition of inactive buildings, facilities, and reactors; removal of surface soil with contamination above remediation levels in the controlled industrial area; remediation of White Oak Lake and White Oak Creek; hydraulic isolation of Solid Waste Storage Areas 1 and 3; and selected groundwater actions for Corehole 8 and East Bethel Valley.

  **Long-term Stewardship** - The CERCLA process will determine any necessary final actions for groundwater in each of the watersheds subsequent to completion of the actions described above. All of the major remedial actions require the need for long-term stewardship actions, including surveillance and maintenance of installed structures and systems, and access and land use controls for as long as necessary to protect human health and the environment.

The life-cycle baseline is generally based on the end uses contained in the CERCLA RODs for areas where these decisions have been approved and on the recommendations of the End Use Working Group for those areas for which decisions have not been made. Minor deviations have been made in some cases based on information that became available subsequent to the CERCLA decisions and/or EUWG recommendations. For example, the EUWG recommended that the eastern-most area in Upper East Fork Poplar Creek could be suitable for unrestricted industrial use, and the EUWG and Phase I ROD for Bear Creek Valley assumed that the western-most portion of Bear Creek Valley could be suitable for unrestricted use; however, the NNSA has since determined that these areas should remain under DOE/NNSA control for the foreseeable future, and the end use for these areas has been designated DOE/NNSA-controlled industrial use for the purpose of this analysis. The current end uses upon which the life-cycle baseline is developed are as follows:

- East Tennessee Technology Park – Unrestricted industrial use (commercial industrial park)

  Melton Valley – Some restricted waste management areas, some DOE-controlled industrial use

  Bethel Valley – Some unrestricted industrial use, some DOE-controlled industrial use
- Upper East Fork Poplar Creek – DOE/NNSA-controlled industrial use
- Bear Creek Valley – DOE/NNSA-controlled industrial use (with some restricted waste management areas)
- Chestnut Ridge – DOE/NSSA-controlled industrial use (with some restricted waste management areas)

Locations of these hazard areas within the DOE Oak Ridge Reservation and the planned end use designation for each area are depicted in Figures 1.1 and 1.2. Additional discussion of each of these hazard areas is provided in Section 4.

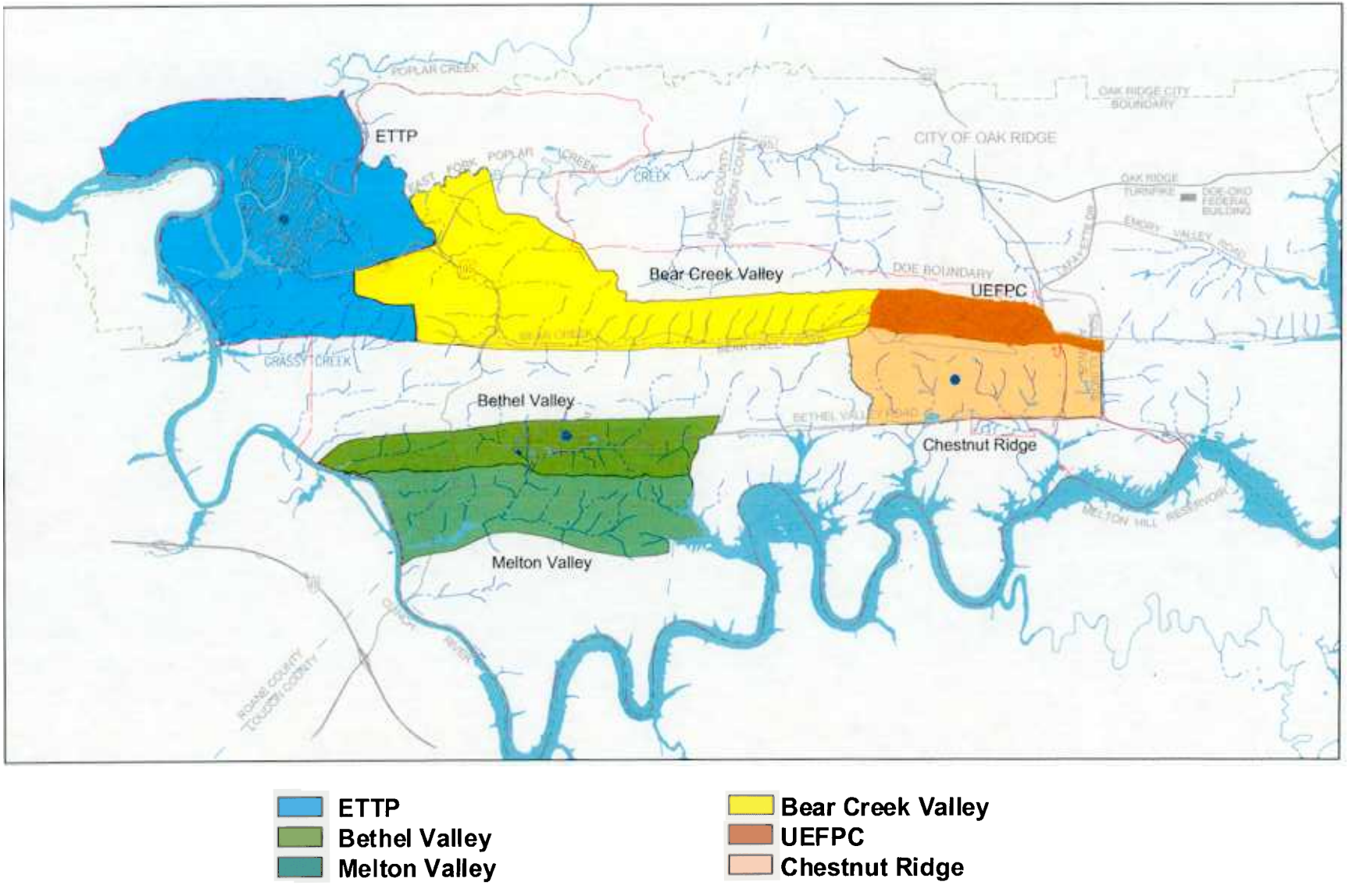



**Figure 1.1 Oak Ridge Reservation watershed decision areas**

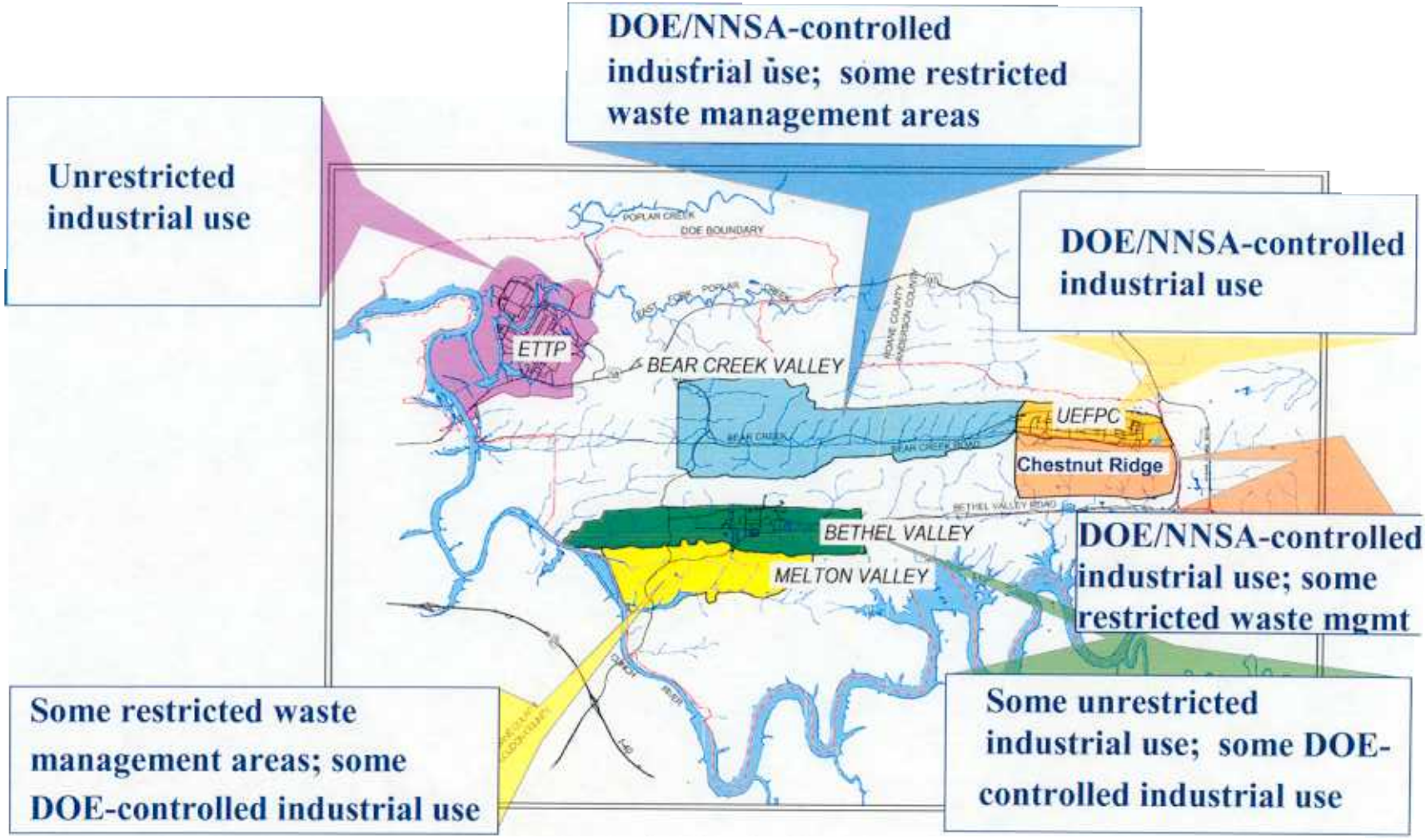



**Figure 1.2 DOE-ORR Hazard Area End-Use Map**

# 2.0 REGIONAL CONTEXT RISK-BASED END STATE DESCRIPTION

## *2.1 Physical and Surface Interface*

The Oak Ridge Reservation is located in east Tennessee in the central portion of the Southern Appalachian region. East Tennessee includes portions of three of the distinct physiographic regions that make up the Southern Appalachian region: the Blue Ridge Mountains, the Valley and Ridge Physiographic Province, and the northern portions of the Cumberland Plateau. The ORR lies within the western portion of the Valley and Ridge Province, a rolling to hilly terrain marked by long linear ridges and drained by the Tennessee River. The ridge and valley topography provides security and isolation for the site but also constrains the land use because of moderate to severe slopes. Figure 2.0 depicts the location of the Oak Ridge Reservation in relation to surrounding counties within east Tennessee.

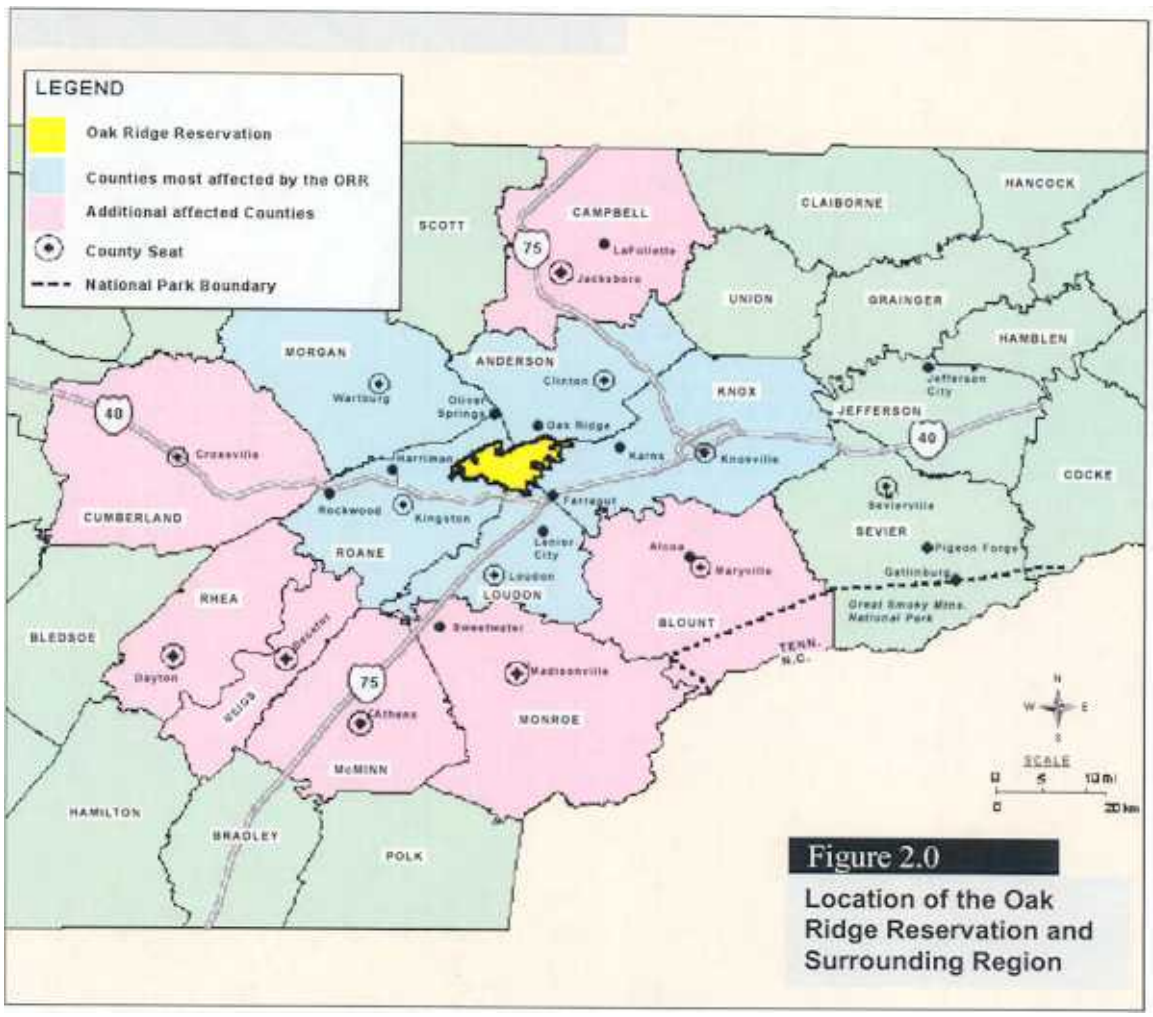



**Figure 2.0**
Location of the Oak Ridge Reservation and Surrounding Region

The 35,000 acre ORR is located adjacent to the city of Oak Ridge, Tennessee, in Roane and Anderson Counties, approximately 15 miles west-northwest of Knoxville. The Clinch River, a tributary of the Tennessee River, bounds ORR on the south. Melton Hill Dam, located on the Clinch River south of ORNL, impounds most of the river on the southern boundary of the ORR to form Melton Hill Reservoir. The Clinch River flows into Watts Bar Reservoir downstream of Melton Hill Dam. All water that drains from the ORR enters the Clinch River and subsequently the Tennessee River.

The ORR is located within 50 miles of three major interstate highways. Interstate 40 (I-40) south of the ORR, is an east-west highway that extends from North Carolina to California. Interstate 75 (I-75), east and south of ORR is a north-south highway that extends from Michigan to Florida. Interstate 81 (I-81) is a northeast-southwest highway that extends from New York to Tennessee and connects with I-40 east of Knoxville. A new northern bypass, I-475, also may be constructed in the future near the ORR.

Figures 2.1a and 2.1b depict the physical and surface interface features of the region surrounding the ORR for the current state and RBES conditions, respectively.

## *2.2 Human and Ecological Land Use*

The region of influence for the ORR consists of Anderson, Knox, Roane, Loudon, and Morgan counties in east Tennessee. These counties are home to over 90% of all ORR employees, comprise a total area of 1.3 million acres, and have a combined population of over 500,000. Oak Ridge and Knoxville are the two largest metropolitan areas within a 50-mile radius, with a 2000 population of 27,387 and 173,890, respectively. The total 2000 census population within a 50-mile radius of ORR was over 900,000. Unincorporated areas surrounding the ORR contain rural population centers in Poplar Creek Valley to the northwest, Sugar Grove Valley to the west, and along the Watts Bar and Melton Hill Reservoirs to the west and south, respectively. These populations represent only a small portion of the population immediately adjacent to the ORR.

Commercial forestry is the leading land use in the five-county area, followed by agricultural, residential, and recreational uses. In general, agricultural land use is declining as residential, commercial, and industrial uses increase. Knox County and Anderson County are the two most highly developed counties in the region of influence, and Morgan County is the least developed. Except for residential and commercial development in the city of Oak Ridge and the Solway community, land use adjacent to the ORR is predominantly rural, consisting of woodlands, small farms, and residences. The city of Oak Ridge has residential areas primarily along the northern and eastern boundaries of the Oak Ridge Reservation, and some Roane County residents have homes adjacent to the western boundary.

*[Insert Figure 2.1a – Regional Physical and Surface Interface – Current State]*

*[Insert Figure 2.1b – Regional Physical and Surface Interface – RBES]*

The Southern Appalachian ecosystem is recognized as one of the most diverse in a temperate region, hosting more than 20,000 species of plants and animals. The ORR forms an important part of this ecosystem because of its relative isolation from widespread impacts since its formation in the1940s. While other areas of the Valley and Ridge Province became increasingly developed and impacted by a growing population, most of the ORR remained undeveloped. The National Environmental Research Park within the ORR is a major component of the Southern Appalachian Biosphere Reserve. The Great Smoky Mountains National Park also is part of the Southern Appalachian Biosphere Reserve.

Figures 2.2a and 2.2b depict the human and ecological land use features of the region surrounding the ORR under current conditions and RBES conditions, respectively. No differences between the current and RBES conditions have been identified.

*[Insert Figure 2.2a – Regional Human and Ecological Land Use – Current State]*

*[Insert Figure 2.2b – Regional Human and Ecological Land Use – RBES]*

# 3.0 SITE SPECIFIC RISK-BASED END STATE DESCRIPTION

## *3.1 Physical and Surface Interface*

The 35,000-acre Oak Ridge Reservation contains three major DOE facilities - ETTP, ORNL, and the Y-12 National Security Complex. These installations occupy approximately 30 percent of the ORR, with the remainder being largely undeveloped. All of the ORR lies within Anderson and Roane Counties, and most of the property is within the corporate city limits of Oak Ridge. The Clinch River forms the southern (Melton Hill Reservoir) and western boundaries of the Oak Ridge Reservation. All water that drains from the ORR enters the Clinch River and subsequently the Tennessee River.

As noted previously, the ORR lies within the western portion of the Valley and Ridge Province, in the Southern Appalachian Region. The topography is marked by long linear ridges and intervening valleys. Streams and tributaries within the ORR are numerous. Most of the northern and central portions of the ORR lie within the watershed of East Fork Poplar Creek and its tributary, Bear Creek. The southern portion of the ORR either lies within the White Oak Creek watershed or drains via short tributaries directly to the Clinch River. Stream flow in tributaries across the ORR varies greatly depending on seasonal precipitation and subsurface geology.

Most of the groundwater underlying the ORR occurs in the overburden and the fractured rock formations, which provide preferential flow pathways usually along "open" fractures in the rock. The predominant groundwater flow directions are parallel to geological bedding and the orientation of the ridges and valleys. Most groundwater flow is shallow, less than 100 feet deep. In general, groundwater movement is minimal below 100 feet in the shale formations because of the lack of "open" fractures in these formations below that depth. Groundwater movement occurs to greater depths in the carbonate formations where fractures have been widened by dissolution of the carbonate rock. Most groundwater discharges to local streams that ultimately flow into the Clinch River, a major tributary to the Tennessee River.

Major roadways in the immediate vicinity of the ORR include the interstate highways discussed previously, I-40 immediately to the south and I-75 to the south and to the east, as well as three state highways that provide access to the ORR for employees and transient traffic. SR-95 forms an interchange with I-40, enters the ORR from the south, and continues northwest and then northeast through the city of Oak Ridge. SR-58 intersects with SR-95 as it enters the ORR from the west. SR-162, the Pellissippi Parkway, is a major link between Knoxville and Oak Ridge to the east of the ORR. Additional major roads within the ORR include Bear Creek Road, Bethel Valley Road, and Blair Road. An extensive network of other paved and unpaved roadways exists within the ORR.

Two main-line rail branches serve the ORR, one at Y-12 and the other at ETTP. An inactive barge terminal is located on the Clinch River at ETTP.

***Figures 3.1a and 3.1b*** depict the physical and surface interface features of the ORR for the current state and RBES conditions, respectively.

*[Insert Figure 3.1a – Site Physical and Surface Interface – Current State]*

*[Insert Figure 3.1b – Site Physical and Surface Interface – RBES]*

## 3.2 Human and Ecological Land Use

The ETTP, ORNL and Y-12 sites occupy approximately 30 percent of the ORR. As noted previously, the ORNL and Y-12 facilities continue to operate as major industrial facilities, with current and ongoing DOE missions of research and development and defense-related manufacturing and stockpile stewardship, respectively. Current activity at ETTP is primarily directed toward environmental remediation, with some commercial industrial use. Future land use at ORNL and Y-12 is expected to continue as DOE/NNSA-controlled industrial use (with some areas dedicated to waste disposal), while ETTP is expected to be developed as a commercial industrial park.

Needs for facility and infrastructure improvements at ORNL are described in the *ORNL Land and Facilities Plan* (UT-Battelle 2002). Similar considerations for the Y-12 site are described in the *Y-12 National Security Complex Ten-Year Comprehensive Site Plan* (BWXT 2003); and a longer-range (30-year) *Master Site Plan* is currently under development. Overall DOE-ORO land use planning under the *ORR Comprehensive Integrated Plan* has determined that most of the Oak Ridge Reservation, with the exception of the ETTP site, will be required for current and future DOE mission needs.

Except for the city of Oak Ridge, the area immediately surrounding the ORR is predominantly rural, including woodlands, small farms and residences. Commercial forestry is the leading land use in the five-county area, followed by agricultural, residential, and recreational uses. The city of Oak Ridge has residential areas primarily along the northern and eastern boundaries of the Oak Ridge Reservation, including four residential areas along the northern boundary that have several houses within approximately 100 ft of the ORR boundary. A few Roane County residents have homes adjacent to the western boundary. The Clinch River, which bounds the ORR to the south and southeast, forms a boundary between Knox County, Loudon County, and portions of Roane County.

Approximately 2% of the ORR is currently open to public use, including the Clark Center Recreation Park, visitor centers, the ORNL Graphite Reactor (National Historical Landmark), cemeteries, roadways, and greenways. Limited hunting is allowed under the auspices of the Tennessee Wildlife Resources Agency to control the deer population. As noted previously, the entire ETTP site is expected to be made available for commercial industrial use.

Remote sensing data from 1994 showed 70 percent of the ORR in forest cover while 20 percent was transitional, consisting of old fields, agricultural areas, cutover forest lands, roadsides, and utility corridors. Less than 2 percent of the ORR remains as open agricultural fields. Currently, 580 acres of wetlands on the ORR provide water quality benefits, stormwater control, wildlife habitat, and landscape and biological diversity. About 3500 acres are used as waste sites or remediation areas. (LMER 1999)

The Oak Ridge National Environmental Research Park (NERP) and the Oak Ridge Wildlife Management Area lie within the boundary of the ORR. The ORNERP was established in 1980, as one of seven DOE parks established throughout the United States to provide protected land for

environmental science research and education. The ORNERP is an ORNL user facility which serves as an outdoor laboratory for the study of present and future impacts on the environment stemming from the various missions at the ORR. The ORNERP was designated as a component of the Southern Appalachian Biosphere Reserve in 1988.

The Oak Ridge Wildlife Management Area was established through a cooperative agreement between DOE and the TWRA in 1984. Most of the ORR is designated a Tennessee Wildlife Management Area through this cooperative agreement, to provide protection of wildlife habitat and species. Wildlife management is carried out under these agreements by TWRA in cooperation with ORNL's Environmental Sciences Division.

In 1999, the Secretary of Energy set aside 3000 acres of ORR as a conservation and wildlife management area in an agreement between DOE and TWRA. The proclamation calls for the land to be cooperatively managed for preservation purposes under a use permit. This area, called the Three Bend Scenic and Wildlife Management Refuge Area, is located in the ORR buffer zone on Freels, Gallaher, and Solway bends on the north shore of Melton Hill Reservoir in Anderson County. TWRA, in consultation with DOE, will prepare a cooperative agreement to serve as a natural resources management plan to establish guidelines for managing this area with the intent to preserve and enhance its natural attributes.

***Figures 3.2a and 3.2b*** depict the human and ecological land use at the ORR for the current state and RBES conditions, respectively.

*[Insert Figure 3.2a – Site Human and Ecological Land Use – Current State]*

*[Insert Figure 3.2b – Site Human and Ecological Land Use – RBES]*

## *3.3 Site Context Legal Ownership*

The Oak Ridge Reservation currently occupies 34,513 acres, mostly within the corporate limits of the City of Oak Ridge. All of this land is titled to the United States of America, and under the jurisdictional control of DOE for administration and management.

The United States Federal Government originally acquired 58,575 acres of land for the ORR between 1942 and 1947. Since that time, ownership of approximately 24,062 acres has been transferred to others. About 25 percent of this total has been transferred to the city of Oak Ridge for development, including: 270 acres for schools; 1083 acres for utilities, drainage, and roads and streets; 1475 acres for municipal properties; and 29 acres for public housing. Of the remaining land tracts: approximately 2315 acres were conveyed to the State of Tennessee for health, forestry, agricultural research, and a biomedical graduate school; 12,686 acres to private ownership; 2992 acres to the Tennessee Valley Authority; 28 acres to Anderson County; 9 acres to the town of Oliver Springs; and 63 acres to other Federal agencies. Land conveyed for private entities and homeowners totals 12692 acres. (DOE 2001)

As a result of a decision by the Secretary of Energy in 1979 allowing DOE to make financial assistance payments to the city of Oak Ridge for a 5-year period under the Atomic Energy Community Act of 1955, the city submitted a self-sufficiency plan which proposed that DOE sell land to the city for industrial/commercial development. This allowed direct transfer of excess land to the city at fair market price rather than turning it over to the General Services Administration for disposal. The self-sufficiency program ended; however, those parcels that were under review at the time were "grandfathered", thus permitting DOE to still consider transfer of land to the city should it become excess to the needs of DOE. (DOE 2001, LMER 1999)

Federal ownership is expected to continue for the foreseeable future. Some portions of the ORR have been transferred to the Community Reuse Organization of East Tennessee (CROET) for commercial development, and additional commercial development, or re-industrialization, is expected to continue. In particular, the future use of ETTP is planned to be unrestricted industrial use as a commercial industrial park. The ORR constitutes approximately 60 percent of the land area within the city limits of Oak Ridge.

Land immediately surrounding the ORR is owned by the city of Oak Ridge, private citizens, the Tennessee Valley Authority, and private industry. Major changes in ownership of these lands are not anticipated.

***Figures 3.3a and 3.3b*** depict the legal ownership of the ORR under the current state and RBES conditions, respectively.

*[Insert Figure 3.3a – Site Context Legal Ownership – Current State]*

*[Insert Figure 3.3b – Site Context Legal Ownership – RBES]*

## 3.4 Site Context Demographics

According to the 2000 census, the population of the city of Oak Ridge is 27,387, and the population of Knoxville is 173,890 (USCB 2004). These values represent increases over the 1990 census totals of 27,310 for Oak Ridge and 165,121 for Knoxville. The 2000 population in the five-county region of influence is approximately 564,000, with more than two-thirds of this total population in Knox County (Knox County, 382,032; Anderson County, 71,330; Roane County, 51,910; Loudon County, 39,086; Morgan County, 19,757).

The ORR has a significant socioeconomic impact on the area. ORR employment represents approximately 5 percent of the total workforce in the five-county area. DOE employees and contractors number more than 13,700 individuals, and these jobs have a higher average salary than the statewide average, $40,000 compared to $25,695 (BEA 1999). DOE employment and spending generate additional benefits to the ROI and state economies through the creation of additional jobs in sectors providing support to DOE and its workers.

Employment in the ROI has historically been dependent on manufacturing and government employment. More recent trends show growth in the service and wholesale and retail trade sectors and a decline in manufacturing and government employment.

There were a total of 206,234 housing units in the ROI in 1990. Approximately 67 percent of these units were single family homes, 24 percent were multifamily homes, and 8 percent were mobile homes. Approximately 7 percent of the housing units were vacant, although some vacant units were used for seasonal, recreational, or other occasional purposes. Owner-occupied housing units accounted for 62 percent of the total housing units while renter-occupied units accounted for approximately 31 percent (USCB 1992).

Eight public school districts with a total of 144 schools provide educational services for the approximately 78,000 students in the ROI. Higher education opportunities in the ROI include the University of Tennessee, as well as several private colleges and community colleges.

Law enforcement is provided by 20 municipal, county, and local police departments that employ over 1500 officers and civilians. Protective forces and security services for the ORR is provided by Wackenhut Services, Inc. under a contract awarded in 2000.

There are 15 hospitals with a total of over 3000 beds, and more than 1500 physicians in the ROI.

***Figures 3.4a and 3.4b*** depict the demographic information for the ORR under the current state and RBES conditions, respectively.

*[Insert Figure 3.4a – Site Context Demographics – Current State]*

*[Insert Figure 3.4b – Site Context Demographics – RBES]*

# 4.0 HAZARD SPECIFIC DISCUSSION

As noted previously, the entire Oak Ridge Reservation was listed as a single entity on the National Priorities List in 1989. In order to facilitate remedial action decision-making, the contaminated areas of the ORR have been divided into the following six areas roughly equivalent to the major hydrologic watersheds:

East Tennessee Technology Park
Melton Valley at the Oak Ridge National Laboratory
- Bethel Valley at the Oak Ridge National Laboratory
- Upper East Fork Poplar Creek at the Y-12 National Security Complex
Bear Creek Valley at the Y-12 National Security Complex
- Chestnut Ridge at the Y-12 National Security Complex

The location of each of these watersheds was shown previously in Figure 1.1. Figures 4.0a and 4.0b also depict these six hazard areas under current and RBES conditions, respectively. Each of these watersheds is discussed in the following sections as a distinct hazard area. Records of Decision have been issued under CERCLA for Melton Valley, Bethel Valley, Bear Creek Valley, part of Upper East Fork Poplar Creek, and part of the East Tennessee Technology Park; and decisions are under development for the remainder of the East Tennessee Technology Park and Upper East Fork Poplar Creek. Additional CERCLA decisions are planned for Chestnut Ridge and for additional actions in Bear Creek Valley. Subsequent CERCLA decisions will determine any additional requirements for groundwater protection and long-term land use controls in each of the watersheds. These hazard areas are discussed in the following sections.

## *4.1 Hazard Area 1 - East Tennessee Technology Park*

The East Tennessee Technology Park is located near the northwest corner of the ORR, in Roane County, Tennessee. ETTP covers an area of approximately 5000 acres; however, only approximately 2200 acres are considered to be potentially impacted by site operations. For purposes of remedial action planning, this potentially impacted area has been subdivided into two areas: Zone 1 consists of approximately 1400 acres located immediately outside the boundaries of the main industrial complex; and Zone 2 consists of the main industrial complex, with an area of about 800 acres. The remaining 2800 acres, located outside of Zone 1 and 2, is referred to as the "footprint reduction area". This area is thought to be unimpacted by site operations, and no remedial actions are currently planned for this area.

Since construction, many operations have been conducted at the ETTP. Enrichment by the S-50 thermal diffusion process took place from 1944-1945. This process proved ineffective and was discontinued. From 1945-1964, the site was a gaseous diffusion enrichment facility for weapons-grade uranium. From 1965-1985, the site produced commercial grade uranium using uranium hexafluoride as feed. A centrifuge enrichment process was operated from the 1960s until 1985. The ETTP also contains many support buildings, including laboratories, maintenance shops, garages, holding ponds/cooling towers, warehouses, disposal areas, power and utilities, waste treatment plants, and decontamination facilities. The site is partially bordered by the

*[Insert Figure 4.0a – Current State Hazard Area Map]*

*[Insert Figure 4.0b – RBES Hazard Area Map]*

Clinch River and its tributary Poplar Creek. Groundwater flows into Mitchell Branch, Poplar Creek, and the Clinch River.

Remedial actions at ETTP are being conducted under three CERCLA decision documents. A ROD was issued in November 2002 for remediation of contaminated soil within Zone 1 (i.e., areas outside the main plant)(DOE 2002a). A second ROD is currently under development for remediation of contaminated soil and structures within Zone 2 (i.e., the main plant area). And a third ROD is also currently under development to address site-wide groundwater contamination and ecological impacts.

Remediation criteria for soils in Zone 1 were derived to limit potential risk to a future site worker not to exceed $1 \times 10^{-5}$ excess lifetime cancer risk (ELCR) for individual carcinogens (with adjustments based on cost considerations where justified) and a cumulative risk of $1 \times 10^{-4}$ ELCR from all contaminants (excluding radium and thorium, for which a non-risk-based alternative concentration limit was selected). Risk from noncarcinogenic contaminants of concern (COCs) was limited not to exceed a Hazard Quotient of 1 for individual COCs and a Hazard Index of 3 from all COCs combined. These values are summarized in Table 4-1.

**Table 4-1. Soil Remediation Criteria from the ETTP Zone 1 ROD**

| Principal COC in Soil | Selected Remediation Concentration-Average |
|---|---|
| Carcinogens | |
| Cesium-137 | 2 pCi/g |
| Radium-226+D | 5 pCi/g * |
| Thorium-232+D | 5 pCi/g * |
| Neptunium-237 | 5 pCi/g |
| Uranium-234 | 700 pCi/g |
| Uranium-235 | 8 pCi/g |
| Uranium-238 | 50 pCi/g |
| PCBs | 10 mg/kg |
| Noncarcinogens | |
| Arsenic | 300 mg/kg |
| Beryllium | 2000 mg/kg |
| Mercury | 600 mg/kg |

*Criteria for the Radium-226+D and Thorium-232+D decay series are non-risk-based values, set at 5 pCi/g above site-specific background concentrations. All other criteria are risk-based concentrations for the protection of a hypothetical future worker, and include any contributions from background.

An exposure unit approach is used, which establishes an average remediation level across an exposure unit that will not be exceeded and a maximum remediation level not to be exceeded at any location. Contaminated soil in each exposure unit will be remediated so that the residual concentration averaged across the exposure unit will be at or below the corresponding average remediation level, and the maximum contaminant concentration found at any location will be at or below the corresponding maximum remediation level. In addition to the remediation levels for

individual contaminants of concern, the cumulative risk to the future worker from all contaminants (excluding the radium and thorium decay series, which use non-risk-based criteria) may not exceed 1 x $10^{-4}$ ELCR and HI≤3.

Decision documents for remediation of soils and structures in Zone 2 and for remedial actions to address site-wide groundwater and surface water contamination and ecological impacts are in early stages of development. While these decisions have yet to be completed, they are being developed using a similar risk-based approach, with target risks similar to those used for Zone 1.

ETTP Current State:

Under current state conditions, the major contaminant sources at the ETTP are:

- Hundreds of aging facilities have become contaminated with radioactive and hazardous substances, including uranium, PCBs and heavy metals, during operations.
- There are approximately 4,700 full uranium hexafluoride cylinders, 1,100 empty cylinders, and 980 cylinder heels located in six locations. The $UF_6$ cylinders are stored outside and are subject to deterioration due to exposure to the elements.
- Soil contamination has occurred from past operations and disposal activities. Contaminants in soils and burial grounds include uranium and other radionuclides, organics, and heavy metals at levels that pose an unacceptable risk.
- There are known contaminated groundwater plumes resulting from the soil contamination and buried wastes.
- Legacy waste is stored in several different locations in both inside storage and outside storage areas in thousands of containers.
- Waste has been buried on-site in several burial grounds.
- Ponds that collect drainage from the site prior to discharge have contaminated sediments.

For Zone 1, characterization data was available to warrant remediation of soil, scrap, and buried materials only in a few discrete areas, based on potential risk to a future industrial worker; these included known areas of contaminated soil in the K-895 Cylinder Destruct Facility area and Powerhouse Area, Blair Quarry, contaminated scrap material and debris in the K-770 Area, and the K-710 sludge beds and Imhoff tanks. Contaminants of concern primarily include radionuclides (primarily uranium), with PCBs contributing significantly only in one exposure unit. For other areas of Zone 1, a dynamic verification strategy was adopted to collect additional characterization data to determine any additional remediation needs. Risk-based remedial action needs for Zone 2 soils and site-wide decisions to address groundwater contamination and ecological impacts have yet to be determined.

Life-Cycle Baseline Plan for ETTP:

The following remedial actions are planned to be completed by 2008 in the current baseline for ETTP:

- Nearly 500 facilities covering about 15 million $ft^2$ will be demolished unless the title is transferred to the Community Reuse Organization of East Tennessee for reindustrialization (approximately 25 of the 500 facilities are currently targeted for possible title transfer).
- The existing inventory of approximately 6,800 $UF_6$ cylinders will be dispositioned. Full and partially filled cylinders will be shipped to the site(s) of the future conversion facility, while the empty cylinders will be directly disposed of at the Nevada Test Site.
- Scrap metal and debris in two scrap yards will be removed for disposal.
- Soil exceeding risk-based cleanup levels for industrial use will be excavated to a maximum depth of 10 ft, and sources of groundwater contamination will be excavated for disposal at ORR or offsite disposal facilities.
- Following the removal of key contaminant sources, assumed groundwater actions at ETTP primarily include monitored natural attenuation and passive in situ treatment.
- Legacy waste (~26,000 $yd^3$) will be disposed at both ORR (CERCLA waste) and offsite disposal facilities (non-CERCLA wastes and mixed waste).
- The K-1070-B and K-1070-C/D burial grounds will be excavated for disposal at ORR or offsite disposal facilities.
- Pond sediments exceeding risk-based remediation levels will be excavated for disposal at ORR or offsite disposal facilities.
- Institutional controls will be maintained in perpetuity to prohibit disturbance of soils at a depth greater than 10 ft below ground surface and to prohibit onsite use of groundwater.

Risk-Based End State Vision for ETTP:

Current baseline plans for ETTP are designed to support the planned end use of this site as a commercial industrial park with minimal or no continuing DOE presence. Remediation criteria have been (Zone 1 ROD) and continue to be (Zone 2 and groundwater RODs) derived to achieve an acceptably low level of risk to the future industrial worker. In most cases, therefore, the actions planned under the current baseline are considered to be entirely consistent with remedial actions designed solely on the basis of the risk-based end state. Only two potential variances have been identified to date:

- While a final decision will not be made until the ETTP Zone 2 ROD is completed, the current baseline plan calls for the K-1070-B and K-1070-C/D burial grounds to be excavated for disposal at ORR or offsite disposal facilities. This remedy is assumed to be most consistent with the desired end use of the ETTP site as an unrestricted commercial industrial park. However, it may be possible to achieve an equally protective remedy, potentially at lower cost, through capping some or all of these materials in place, particularly for the K-1070-C/D burial grounds. Containment alternatives for K-1070-B are considered more difficult, as buried waste materials are thought to sit in the saturated zone. Since the K-1070-C/D burial grounds contain classified materials, consideration of security requirements required for implementation of both alternatives must be included in the comparative analysis of alternatives.
- The great majority of buildings currently remaining at ETTP will be demolished during the site closure process. Only those buildings which have a specific identified future use by

private industry will remain, with titles transferred to CROET. These remaining buildings may contain residual radiological contamination on building surfaces (walls, floors, structural beams, etc) that may require decontamination to levels sufficiently protective for future occupants. Current cleanup operations at ETTP are based on surface radioactivity limits specified in DOE Order 5400.5, Table IV-1. Under the RBES, dose-based criteria will be derived specifically for the radionuclides of concern at each building and the designated future use scenarios for that building. These criteria will be derived to limit the potential radiation dose and health risk to future building occupants to levels that are determined to be protective and consistent with DOE policy to reduce exposures as low as reasonably achievable (ALARA). Implementation of dose-based criteria for surface contamination at ETTP will significantly reduce potential risks to decontamination workers, while still limiting risks to public health and the environment to acceptably low levels.

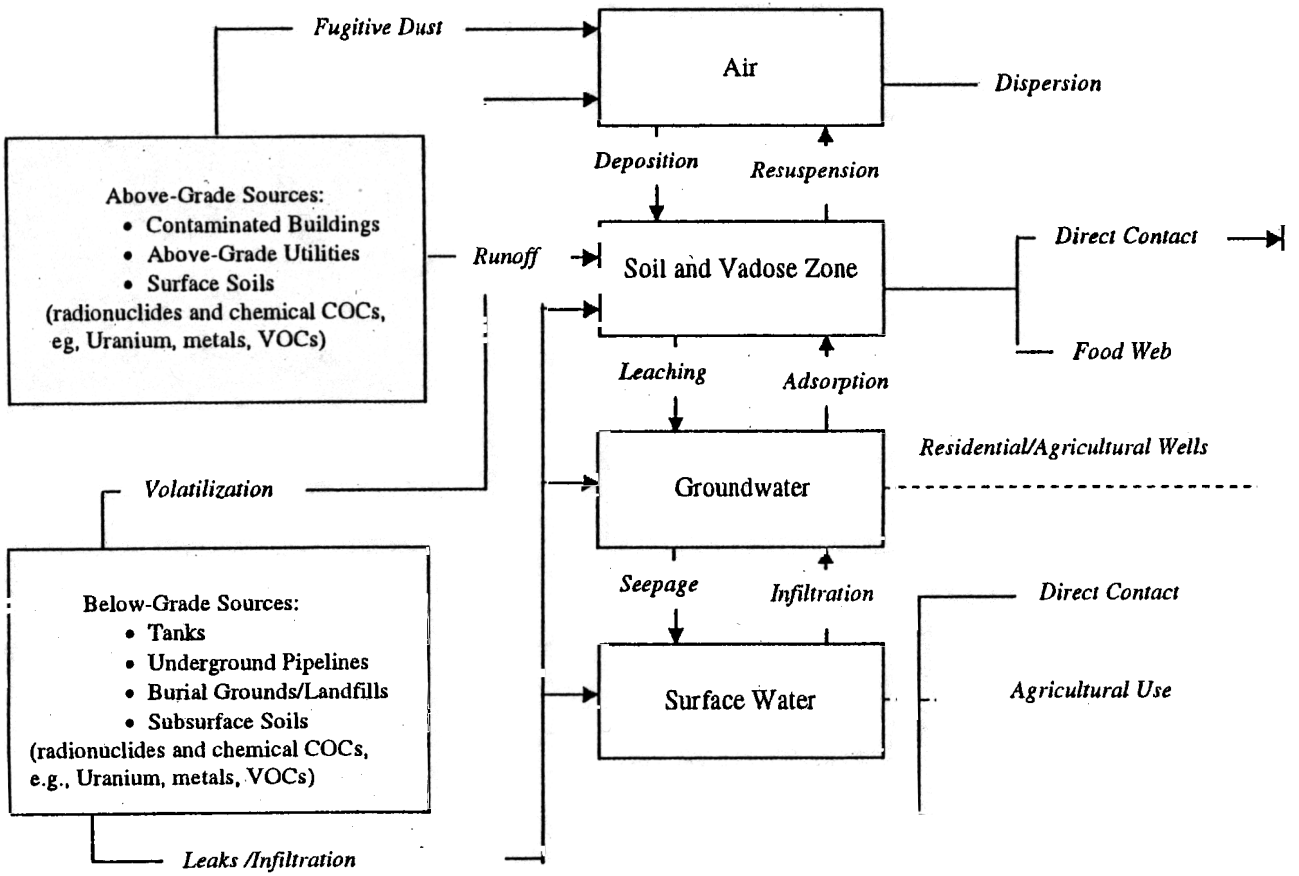
Maps of the ETTP site under current and RBES conditions are provided in Figures 4.1a1 and 4.1.b1. Conceptual site models under current state and RBES conditions are illustrated in Figures 4.1a2 and 4.1b2, respectively.

Under both the baseline and RBES remediation scenarios for ETTP, contaminated buildings, soils and other materials exceeding risk-based criteria for future industrial use will be removed from the site for off-site disposal. Baseline and RBES scenarios vary only with respect to the management of buried wastes in a small portion of the site and the criteria selected for decontamination of building surfaces. Thus, Figure 4.1b2 indicates primary sources to be removed above-grade, while some below-grade sources may remain within containment systems. In either case, a long-term stewardship program will ensure the continuing protectiveness of the remedy, including continuing surveillance and maintenance. The containment system for capped areas will require periodic maintenance and repair to minimize the potential for failure. Groundwater monitoring wells will require periodic maintenance and replacement at longer (~ 30-year) intervals. Since contaminants will remain on site above levels suitable for unlimited use and unrestricted exposure, a statutory review will be conduct at least every five years to ensure that the remedy continues to be protective of human health and the environment.

*[Insert Figure 4.1a1 – Hazard Area 1 (ETTP) Map – Current State]*

*[Insert Figure 4.1b1 – Hazard Area 1 (ETTP) Map – RBES]*

*Figure 4.1a2, Conceptual Site Model - Hazard Area 1, ETTP  Current State*




| Potential Receptor Exposed | | | |
|---|---|---|---|
| Onsite Worker | Offsite Recreational | Offite Resident | Ecological |
| I/D/R | | | I/D/R |
| D/R | | | D/R/F |
| | F | | F |
| D/R | D/R | | D/R/F |

**KEY**

→ Active transport, uptake, or exposure pathway

- - - → Blocked or mitigated transport, uptake, or exposure pathway

R – Direct Radiation Exposure

*Figure 4.1a2, Conceptual Site Model - Hazard Area 1, ETTP – Current State*

**Narrative:**

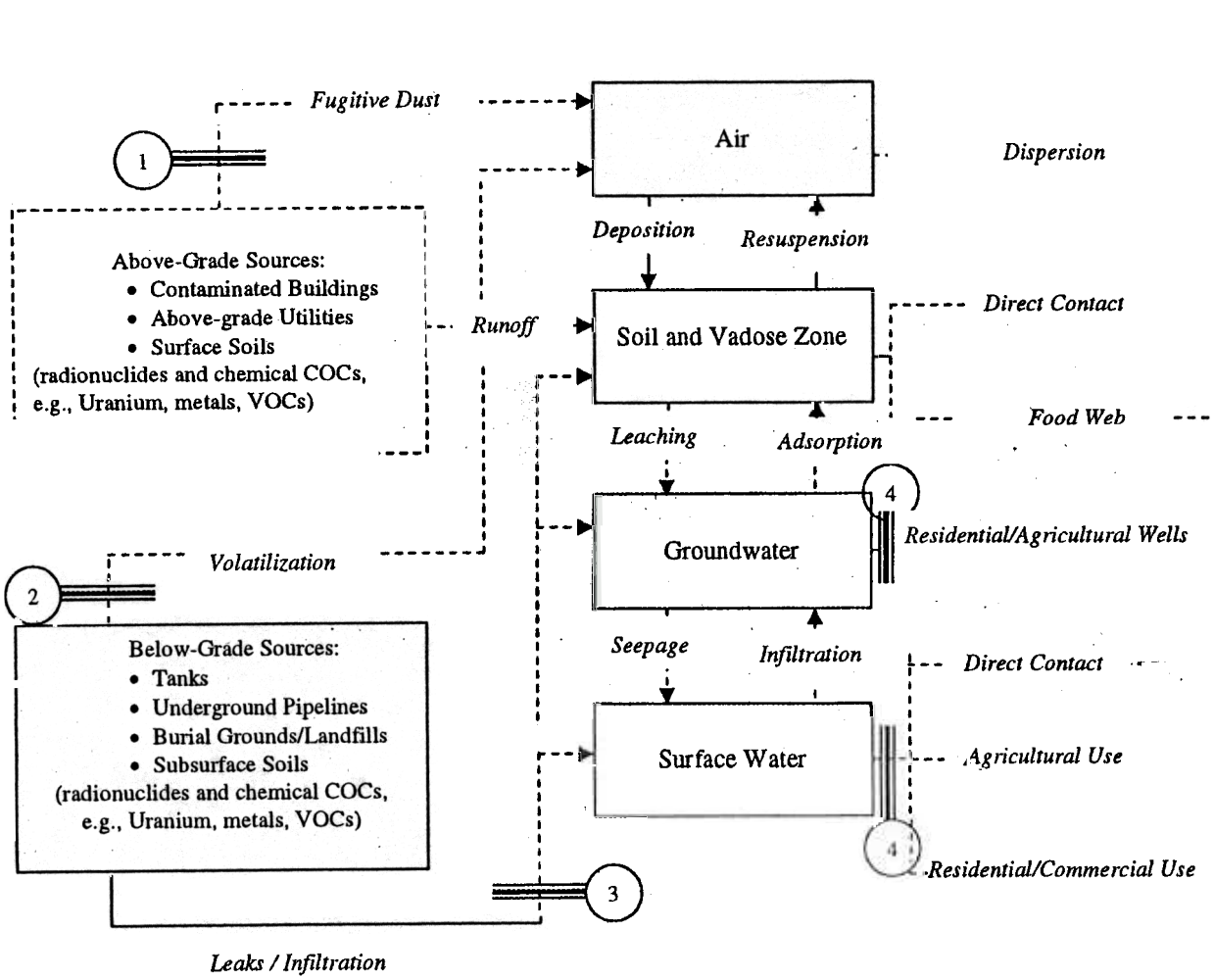
**Contaminant Sources:**

Under current state conditions, numerous buildings, above- and below-grade pipelines and other utilities, tanks, soils and waste burial grounds contain contaminants of concern in concentrations above site remediation levels. Contaminants of concern include radionuclides (primarily uranium), metals, VOCs, and PCBs.

**Current State Exposure Pathways and Receptors:**

Under current conditions, potentially complete exposure pathways for onsite workers include: inhalation of particulates or volatiles; and direct exposure to radiation in soils, buildings/structures, waste and surface water. Potentially complete exposure pathways to off-site recreationists include direct contract with surface water and ingestion of fish. Ecological receptors potentially may be exposed to contaminants in air, soil, surface water and the food chain. No potentially complete exposure pathways to offsite residents have been identified. There is no current use of groundwater or surface water at ETTP for residential, commercial, or agricultural purposes.

*Figure 4.1b2, Conceptual Site Model – Hazard Area 1, ETTP – RBES*




| Potential Receptor Exposed | | | |
|---|---|---|---|
| Onsite Worker | Offsite Recreational | Offite Resident | Ecological |
| I/D/R | - | - | I/D/R |
| D/R | - | - | D/R/F |
| - | F | - | F |
| - | - | - | - |
| D/R | D/R | - | D/R/F |
| - | - | - | - |
| - | - | - | - |

**KEY**

Active transport, uptake, or exposure pathway

Blocked or mitigated transport, uptake, or exposure pathway

Engineered barrier or administrative control – sequentially numbered

I – Inhalation
D – Dermal contact R – Direct Radiation Exposure
F – Ingestion

*Figure 4.1b2, Conceptual Site Model – Hazard Area 1, ETTP – RBES*

**Narrative:**

**Contaminant Sources:**

Under both current life-cycle baseline and Risk-Based End State conditions, ETTP will be released from DOE control for reuse as a commercial idustrial park. All buildings, pipelines and other utilities, soils, and other sources containing contaminants above remediation critieria for industrial use will be removed for offsite disposal. Residual contamination below the risk-based remediation criteria will remain in soils, sediments, surface water and groundwater, that will preclude unrestricted use of the site but will not pose unacceptable risk to future receptors under the selected industrial land use. Institional controls will include restrictions on future groundwater use.

**Risk-Based End State Barriers/Interventions:**

The steps taken to mitigate or remove these hazards are as follows:

1. Contaminated buildings, utilities and soils above risk-based remediation criteria will be removed for offsite waste disposal. Only those buildings selected for commercial industrial use will remain onsite, with title transferred from DOE to CROET. Residual contaminant levels will be below levels of concern for fugitive dust emissions.

2. Contamination above risk-based remediation levels in tanks, below-grade pipelines and utilities, and soils will be contained and/or removed for offsite disposal, eliminating potential for airborne emissions. Buried wastes would be excavated for offsite disposal under the current baseline plan, but would be contained in place by capping under the RBES. Residual contamination levels also will be below levels of concern for direct radiation exposure.

3. Remediation of contamination above risk-based remediation levels in tanks, below-grade pipelines and utilities, soils, and buried waste also will eliminate potential for continuing releases to surface water or groundwater. Residual contamination levels also will be below levels of concern for direct radiation exposure.

4. Future land use is restricted to industrial use, with prohibitions on groundwater and surface water use. Long-term stewardship and institutional controls will ensure continuing protectiveness of the remedy. Surveillance and maintenance will include monitoring of surface water and groundwater, with periodic maintenance and replacement of groundwater wells and ongoing maintenance of capped areas as required.

## 4.2 Hazard Area 2 - Melton Valley

The Melton Valley watershed occupies approximately 1000 acres in the southern portion of ORNL at the southwestern boundary of the ORR. The watershed is bounded on the north by the Bethel Valley watershed and on the west by the Clinch River. It is separated from Bethel Valley by Haw Ridge. Waste management was historically the principal activity that took place in Melton Valley, although research and development for two nuclear reactors also took place there. As a result of past operations, Melton Valley contains numerous burial grounds, seepage pits, contaminated floodplains and hydrofracture wastes. These wastes originated both from local operations and from other sites. The bulk of disposal activities involved shallow land burial. In some cases, wastes are in constant contact with groundwater, resulting in shallow groundwater contamination. From 1955 to 1963, Solid Waste Storage Areas (SWSAs) 4 and 5 in Melton Valley were designated by the Atomic Energy Commission (AEC) as the Southern Regional Burial Ground, and received radioactive wastes from more than 50 other facilities.

White Oak Creek flows from Bethel Valley into Melton Valley at ORNL. Tributaries to White Oak Creek drain waste disposal areas in Melton Valley. White Oak Creek exits the ORR through White Oak Lake, over the White Oak Dam, and into the Clinch River. Strontium-90, tritium, and cesium-137 are the primary contaminants of concern in surface water leaving the Melton Valley watershed.

The *Record of Decision for Interim Actions for the Melton Valley Watershed* (DOE 2000) was approved on September 21, 2000, and an Explanation of Significant Differences (ESD) was issued in 2003 (DOE 2003c) to add remedial actions for four additional waste management units to the scope of the ROD. Remedial actions selected under the ROD include a combination of containment, stabilization, removal, treatment, monitoring, and land use controls. Remedial actions under this ROD were designed to support the following land uses: the eastern portion of the Melton Valley watershed will be remediated to permit DOE-controlled industrial use, while the western portion of the watershed, where numerous waste disposal sites are located, will continue to be a waste management area, with most wastes managed in place. The selected remedial actions are designed to significantly reduce the release of contaminants from the Melton Valley source areas into White Oak Creek, Melton Branch, their tributaries, and the Clinch River. The selected remedy leaves hazardous substances in place which require land use controls for the foreseeable future, with approximately 2 million curies of radioactivity closed in place under 128 acres of caps.

Remediation criteria are specified in the Melton Valley ROD for soils, floodplain sediments, and surface water. Remediation goals for surface water are to achieve Ambient Water Quality Criteria (AWQC) in waters of the State of Tennessee, protect an off-site resident user of surface water, and protect the Clinch River to meet its stream use classification. Remediation of surface water sediment was deferred to a future decision. Remedial action for floodplain soils at White Oak Creek, Melton Branch, and other tributaries is limited to removal of the most highly contaminated floodplain soil (i.e., soils where gamma exposure rate exceeds 2500 μR/hr) to protect site workers. Remediation criteria for soils were derived to limit potential risk to a

hypothetical future worker not to exceed 1 x $10^{-4}$ excess lifetime cancer risk; these values are summarized in Table 4-2.

**Table 4-2. Soil Remediation Criteria from the Melton Valley ROD**

| Principal COC in Soil | Selected Remediation Concentration |
|---|---|
| Carcinogens | |
| Aroclor 1260 | 47 mg/kg |
| Cobalt-60 | 7.4 pCi/g |
| Strontium-90 | 1200 pCi/g |
| Cesium-137 | 14 pCi/g |
| Europium-154 | 11 pCi/g |
| Lead-210 | 270 pCi/g |
| Radium-226 | 5 pCi/g* |
| Radium-228 | 5 pCi/g* |
| Thorium-228 | 5 pCi/g* |
| Thorium-232 | 5 pCi/g* |
| Uranium-233 | 5100 pCi/g |
| Uranium-234 | 6000 pCi/g |
| Uranium-235 | 81 pCi/g |
| Uranium-238 | 310 pCi/g |
| Noncarcinogens | |
| Arsenic | 330 mg/kg |

*Criteria for the Radium-226 and Thorium-232 decay series are non-risk-based values, set at 5 pCi/g above site-specific background concentrations. All other criteria are risk-based concentrations for the protection of a hypothetical future worker, and include any contributions from background.

Similarly to the exposure unit approach described previously for ETTP, both an average remediation level (averaged across the exposure unit) and a maximum remediation level (not to be exceeded at any location) is specified for each contaminant of concern. However, the method used to address multiple contaminants differs. Where multiple COCs are present within an exposure unit, a sum-of-the-ratios approach must be used to ensure that the cumulative risk to the future worker from all contaminants may not exceed 1 x $10^{-4}$ ELCR (excluding the radium and thorium decay series) and HI≤3.

Melton Valley Current State:

The major areas of contamination in Melton Valley are described below:

- White Oak Creek, White Oak Lake, their tributaries and adjacent lands contain sediments contaminated with cesium-137 and cobalt-60.
- Solid Waste Storage Area 4 was used for disposal of solid low-level wastes in trenches and auger holes. This area is a significant source of strontium-90 levels at White Oak dam where

surface water from Melton Valley is released toward the Clinch River from White Oak Lake. Groundwater contaminants are strontium-90, tritium and transuranic elements.

- Solid Waste Storage Area 5 was used for disposal of low-level radioactive wastes in trenches and auger holes. Approximately 1800 curies of tritium are released annually from this area to the Clinch River via the White Oak Dam. The most heavily contaminated groundwater wells in Melton Valley are located in this area. Groundwater contaminants are transuranic elements, strontium-90, tritium, and volatile organic compounds.
- Solid Waste Storage Area 6 was used for low-level waste disposal into trenches, auger holes and silos. Groundwater contaminants are organic solvents and tritium.
- Waste pits and trenches were used from 1951 to 1966 for disposal of liquid low-level radioactive wastes. Wastes were piped into these seepage pits, resulting in extensive soil contamination. Groundwater contaminants are strontium-90, cobalt-60, and transuranic elements.
- The Homogeneous Reactor Experiment (HRE) pond received contaminated condensate and shielding water during the operation of the HRE reactor from 1958 to 1962. The pond has been frozen using a cryogenic barrier demonstration to reduce the releases of radionuclides to surface water.
- Hydrofracture injection wells were used for the disposal of liquid waste. In the hydrofracture process, waste containing up to one million curies was mixed with cement grout. This mixture was pumped under pressure via injection wells into the Pumpkin Valley Shale geologic formation,.located 700 to 1000 feet below the surface, where groundwater is 10 times more saline than seawater and is not part of an active groundwater flow system. There are no known releases to surface water, sediments, or surface soils from the hydrofracture process. There is some speculation that pressure below the hydrofracture zone may cause water to flow up boreholes or wells.
- Soil has been contaminated by spills and leaks from the disposal operations.

The Baseline Risk Assessment (DOE 1997a) for Melton Valley concluded that radionuclides in contaminated soils and sediments present unacceptable risk levels ($<1 \times 10^{-4}$ ELCR) for industrial, recreational and residential exposure scenarios. The predominant exposure pathway is direct external exposure to gamma radiation, primarily due to Cesium-137 (median concentration in soil = 162 pCi/g, maximum = 700,000 pCi/g) and Cobalt-60 (median concentration in soil = 15 pCi/g, maximum = 500,000 pCi/g). Potential ecological risk to terrestrial biota also was identified for radionuclides, metals, and PCBs in soil and sediment, although lines of evidence were limited.

Life-Cycle Baseline Plan for Melton Valley:

The following remedial actions are planned to be completed by 2006 in the current baseline for Melton Valley:

- Multi-layer caps will be installed in Solid Waste Storage Areas 4, 5, and 6 and in portions of the Seepage Pits and Trenches Area. Collection drains will be installed downgradient of capped areas in Solid Waste Storage Area 4, Solid Waste Storage Area 5 South, and in the

Seepage Pits and Trenches Area to increase the effectiveness of hydraulic isolation. The collected groundwater will be treated to meet discharge limits.

- Readily retrievable transuranic waste will be removed from the lower 22 transuranic trenches in Solid Waste Storage Area 5 North. The removed waste will be segregated at the Transuranic Waste Treatment Facility and will be sent to Waste Isolation Pilot Plant for disposal.
- Sediment and soil from the Homogeneous Reactor Experiment (HRE) Pond and four High Flux Isotope Reactor (HFIR) impoundments will be excavated and disposed in the Environmental Management Waste Management Facility. Floodplain soil and sediment that exceed agreed-upon levels in the Melton Valley Record of Decision will be excavated and either disposed in the Environmental Management Waste Management Facility or used as contour fill under the various multi-layer caps. Hot spots in the waste management area (around Solid Waste Storage Areas 4, 5, and 6 and the Seepage Pits and Trenches Area) generally will be capped. Hot spots in the industrial use area (east of Solid Waste Storage Area 5) generally will be excavated and either disposed in the Environmental Management Waste Management Facility or used as contour fill under the various multi-layer caps. Inactive waste pipelines will be isolated, stabilized, or removed, as necessary, to address residual contamination.
- The New Hydrofracture Facility and Waste Management Facilities in Solid Waste Storage Areas 5 and 6 will be demolished.
- In situ vitrification will be used as a cost-effective treatment for Trenches 5 and 7 in the Seepage Pits and Trenches Area.
- In situ grouting will be used for the Homogeneous Reactor Experiment (HRE) fuel wells in the Seepage Pits and Trenches Area.
- Plugging and abandonment will be used to isolate four hydrofracture injection wells and associated monitoring wells that interfere with installation of multi-layer caps and other cleanup activities.
- The Spent Nuclear Fuel will be retrieved, repackaged, and transported to the Idaho National Environmental Engineering Laboratory for disposal.
- Approximately 6,100 $yd^3$ of low-level radioactive waste stored in Melton Valley will be disposed offsite prior to capping.
- Institutional controls will be maintained in perpetuity to control future land use, to restrict access to capped waste disposal areas, and to prohibit onsite use of groundwater.

Risk-Based End State Vision for Melton Valley:

Current baseline plans for Melton Valley are designed to support the planned end use for the different areas of this site – i.e., the majority of Melton Valley will be a dedicated waste management area with restricted access, while a portion of the site will be suitable for DOE-controlled industrial use. Remediation criteria were derived to achieve an acceptably low level of risk to the future worker in each of these areas. In most cases, therefore, the actions planned under the current baseline are considered to be entirely consistent with remedial actions designed solely on the basis of the risk-based end state. Only one potential variance has been identified to date:

- The current baseline plan calls for use of in-situ vitrification (ISV) technology for remediation of buried waste at Trenches 5 and 7 located in the Seepage Pits and Trenches Area of Melton Valley. ISV was selected for use in these areas because these trenches hold a large inventory of radionuclides in a relatively small volume of waste within a small contaminated area. ISV was not proposed for use at other locations within Melton Valley because of the difficulty in using this technology in heterogeneous waste, the potential hazard of using ISV in saturated waste, and the overall high cost of ISV relative to other remediation technologies. Previous demonstration projects using ISV technology at Melton Valley sites near the Trench 5 and 7 area were unsuccessful, partially due to high moisture content of the trench contents. Recent data indicate higher levels of moisture in Trenches 5 and 7 than previously thought, which may adversely affect the implementation of ISV technology at these sites. As a result of this and other factors, estimates for both cost and implementation time for the ISV remedy have increased significantly relative to the ROD. Selected remediation measures for adjacent areas already include use of in-situ grouting and capping using a multi-layer cover system. Implementation of the in-situ grouting and capping remediation technologies for the Trench 5 and 7 sites, in lieu of ISV, will be protective to human health and the environment under the selected end-state land use for this area (i.e., protection of the worker in this dedicated waste management area), with less schedule risk and potentially lower cost.

It is important to note that the remedial actions for Melton Valley are well underway and are scheduled for completion in FY2006. Remediation of several areas has been completed (e.g., decontamination and decommissioning of the Old Hydrofracture Facility, removal of contaminated soil from the Intermediate Holding Pond) and significant construction work is currently in progress in other areas (e.g., plugging and abandonment of the Hydrofracture wells, capping and hydraulic isolation of SWSA 4). Due to the advanced stage of remedial actions and the accelerated schedule for completion, as well as the heavy emphasis on end use controls already in the selected remedy, Melton Valley does not appear to be a good candidate for change based on the RBES Vision, with the exception of the variance noted above, which is expected to have a beneficial schedule impact.

Maps of the Melton Valley watershed under current and RBES conditions are provided in Figures 4.2a1 and 4.2.b1. Conceptual site models under current state and RBES conditions are illustrated in Figures 4.2a2 and 4.2b2, respectively.

Baseline and RBES scenarios for Melton Valley differ only with respect to the technology used for stabilization of buried wastes in a small portion of the site. In either case, a long-term stewardship program will ensure the continuing protectiveness of the remedy, including continuing surveillance and maintenance. The containment system for capped areas throughout Melton Valley will require periodic maintenance and repair to minimize the potential for failure. Groundwater monitoring wells will require periodic maintenance and replacement at longer intervals (~30 years). Since contaminants will remain on site above levels suitable for unlimited use and unrestricted exposure, a statutory review will be conduct at least every five years to ensure that the remedy continues to be protective of human health and the environment.

*[Insert Figure 4.2a1 – Hazard Area 2 (Melton Valley) Map – Current State]*

*[Insert Figure 4.2b1 – Hazard Area 2 (MeltonValley) Map – RBES]*

*Figure 4.2a2, Conceptual Site Model - Hazard Area 2, Melton Valley – Current State*

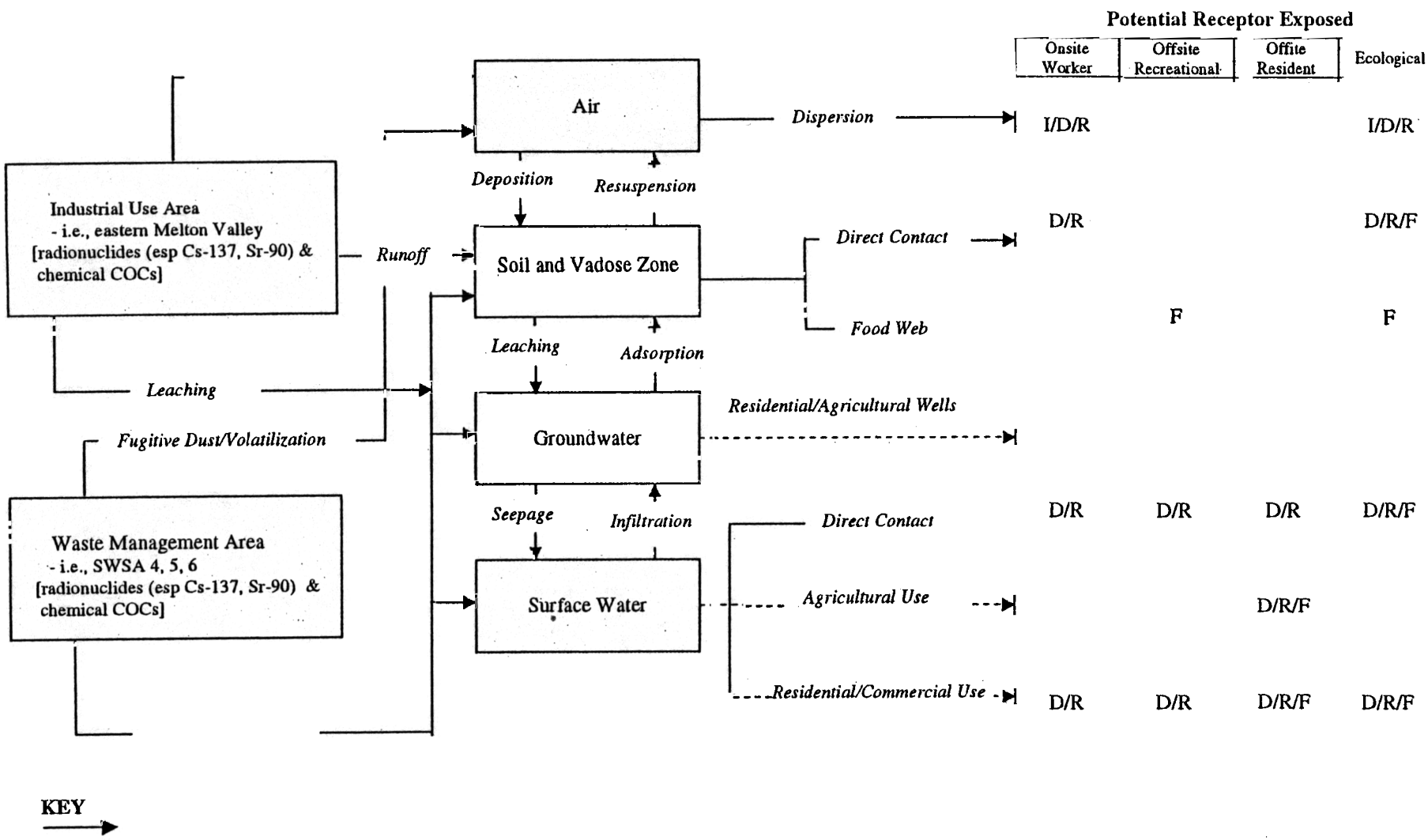


*Figure 4.2a2, Conceptual Site Model - Hazard Area 2, Melton Valley – Current State*

**Narrative:**

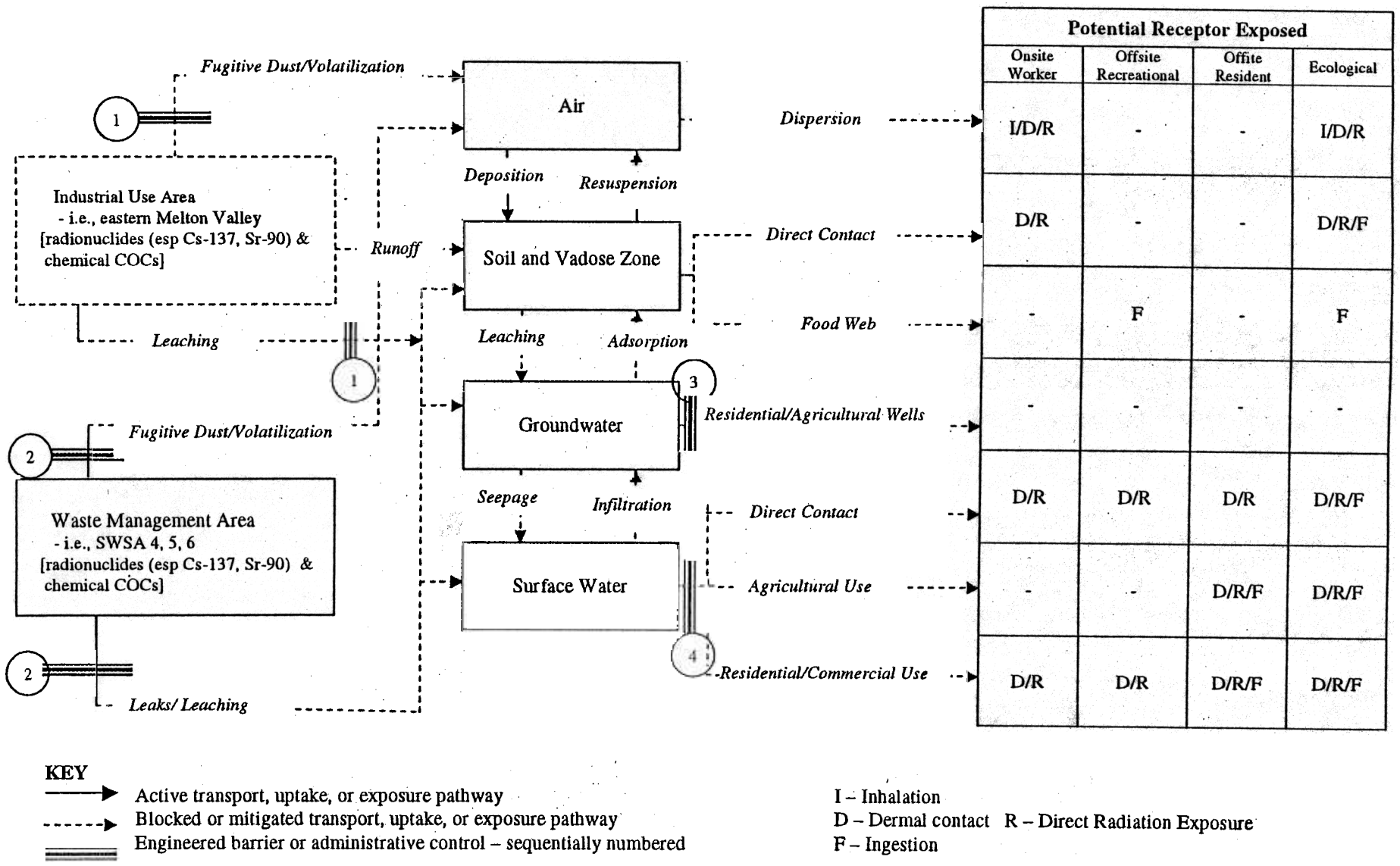
**Contaminant Sources:**

Melton Valley is currently undergoing an extremely aggressive remedial action program, scheduled for completion in 2006. Numerous waste management facilties within Melton Valley [i.e., Solid Waste Storage Areas (SWSAs) 4, 5, and 6] have been used for disposal of radioactive and hazardous wastes for over a half-century. While the list of contaminants of concern is understandably lengthy, a few fission products contribute the great majority of risk, notably Cs-137 and Co-60 in soil and sediments, and Sr-90 in surface water. Under the existing CERCLA ROD, remediation criteria for contaminants of concern in soil and other media were derived to limit risks to the future DOE industrial workers not to exceed $1 \times 10^{-4}$ ELCR and HI<3. Institional controls include restrictions on access to the waste management areas and restrictions on future groundwater and surface water use throughout Melton Valley.

**Current State Exposure Pathways and Receptors:**

Under current conditions, potentially complete exposure pathways for onsite workers include: inhalation of resuspended particulates or volatiles; and direct exposure to contaminants in soils, waste and surface water. While Melton Valley is not normally accessible to recreational users, potentially complete exposure pathways to off-site recreationists include direct contract with surface water and ingestion of fish. Ecological receptors potentially may be exposed to contaminants in air, soil, surface water and the food chain. Surface water in Melton Valley enters White Oak Creek and flows to White Oak Lake, where it exits the ORR. Potentially complete exposure pathways to offsite residents include direct contact with surface water after exiting the ORR, fish ingestion, and use of surface water for irrigation of home gardens. There is no current use of groundwater or surface water in Melton Valley for residential, commercial, or agricultural purposes.

*Figure 4.2b2, Conceptual Site Model – Hazard Area 2, Melton Valley – RBES*




| Potential Receptor Exposed | | | |
|---|---|---|---|
| Onsite Worker | Offsite Recreational | Offite Resident | Ecological |
| I/D/R | - | - | I/D/R |
| D/R | - | - | D/R/F |
| - | F | - | F |
| - | - | - | - |
| D/R | D/R | D/R | D/R/F |
| - | - | D/R/F | D/R/F |
| D/R | D/R | D/R/F | D/R/F |

**KEY**

Active transport, uptake, or exposure pathway

Blocked or mitigated transport, uptake, or exposure pathway

Engineered barrier or administrative control – sequentially numbered

I – Inhalation

D – Dermal contact R – Direct Radiation Exposure

F – Ingestion

*Figure 4.2b2, Conceptual Site Model – Hazard Area 2, Melton Valley – RBES*

**Narrative:**

**Contaminant Sources:**

Melton Valley is currently undergoing an extremely aggressive remedial action program, scheduled for completion in 2006. Under both current life-cycle baseline and Risk-Based End State conditions, a major portion of the Melton Valley watershed will be dedicated to permanent disposal of radioactive and hazardous waste, while the remainder of the site will be available for future DOE-controlled industrial use. Contaminants of concern include Cs-137 and Co-60 in soil and sediments, and Sr-90 in surface water. Remediation criteria for contaminants of concern in soil and other media were derived tolimit risks to the future DOE industrial workers not to exceed $1 \times 10^{-4}$ ELCR and HI<3. Institional controls include restrictions on access to the waste management areas and restrictions on future groundwater and surface water use throughout Melton Valley.

**Risk-Based End State Barriers/Interventions:**

The steps taken to mitigate or remove these hazards are as follows:

. Contaminated buildings and soils within the areas designated for future DOE-controlled industrial use within Melton Valley will be remediated such that contaminants of concern do not exceed risk-based remediation criteria for industrial use. Contaminated media above remediation criteria generally will be removed and either disposed at the EMWMF disposal facility or used as contoured fill under the various multi-layer caps (see item 2 below). Residual contaminant levels will be below levels of concern for fugitive dust emissions/volatilization or direct radiation exposure.

2. Most waste disposal areas within Melton Valley will be contained in place via installation of multi-layer engineered cover systems and other hydraulic controls - this includes waste disposal sites within SWSA 4, SWSA 5, and SWSA 6. In addition, the extensive network of underground pipelines will be grouted in place, numerous wells will be plugged and abandoned. In each case, the engineered containment systems will preclude unacceptable exposures to workers or releases of contaminants to the environment above levels of concern. Institutional controls will be maintained in perpetuity to restrict access to the capped waste disposal areas.

3. Future land use within Melton Valley will be restricted to DOE-controlled industrial use, with a major portion of the watershed dedicated to permanent waste disposal operations. Institutional controls will include permanent prohibitions on groundwater use. Long-term stewardship and institutional controls will ensure continuing protectiveness of the remedy. Surveillance and maintenance will include monitoring of surface water and groundwater, with periodic maintenance and replacement of groundwater wells and ongoing maintenance of capped areas as required.

4. Remediation of surface water and sediment in White Oak Creek has been generally deferred to a future CERCLA decision. Only limited removal of elevated areas of radiological contamination in floodplain soils (>2500 uR/hr) is addressed under the existing ROD for Melton Valley. It is anticipated that the actions described in items 1 and 2 above, along with other remedial actions for Bethel Valley, will significantly reduce the flux of contaminants into White Oak Creek and White Oak Lake, which are ultimately discharged to the Clinch River upon exiting the ORR. Institutional controls include restrictions on current use of surface water within Melton Valley.

## 4.3 Hazard Area 3 - Bethel Valley

The Bethel Valley watershed encompasses approximately 1700 acres, including the main industrial complex of Oak Ridge National Laboratory. Bethel Valley is defined by the upper drainage area of White Oak Creek and its tributaries and extends from the Clinch River at its west end to the easternmost boundary of ORNL. The northern boundary lies somewhat north of Bethel Valley Road; the southern boundary is the crest of Haw Ridge, which is the hydrologic divide between Bethel Valley and Melton Valley. Bethel Valley includes the main administrative offices and research facilities of ORNL. Bethel Valley is subdivided into four regions with varied land use and level of contamination: Raccoon Creek, West Bethel Valley, Central Bethel Valley, and East Bethel Valley. Raccoon Valley is located west of Highway 95 and is wooded land that contains no known contamination source areas but slightly contaminated media that have migrated from West Bethel Valley. East Bethel Valley includes the ORNL plant maintenance area, Central Bethel Valley includes the main ORNL plant area, and West Bethel Valley contains a burial ground and a small portion of the plant area.

ORNL was originally constructed in 1943 to produce the first gram quantities of plutonium for use in the atomic bomb for the Manhattan Project during World War II. After the war, it was established as a national laboratory and it continues to conduct applied research and engineering development in support of DOE programs in nuclear energy, fusion, energy conservation, fossil fuels, and other energy technologies, and to perform basic and applied scientific research and development in physical, chemical, materials, biological, environmental, social and computational sciences. ORNL's operations during the past 60 years have resulted in a legacy of sites and facilities contaminated with a wide variety of hazardous and radioactive materials. Contaminated sites include numerous tanks, four surface impoundments, reactors and associated buildings, buried waste transfer pipelines, and burial grounds and landfills. Interim actions have been conducted under CERCLA for several Bethel Valley facilities, notably including the Surface Impoundment Operable Unit (SIOU), the Gunite and Associated Tanks, and the Corehole 8 Plume.

The *Record of Decision for Interim Actions Bethel Valley* (DOE 2002b) was approved on May 2, 2002. Remedial actions selected under the ROD include a combination of containment, stabilization, removal, treatment, monitoring, and land use controls. The selected remedial actions are designed to significantly reduce the release of contaminants from Bethel Valley sources into White Oak Creek and subsequently the Clinch River. White Oak Creek is the primary exit pathway for mobile contaminants in Bethel Valley. The point of integration for contaminants in Bethel Valley is where White Oak Creek exits the watershed at 7500 Bridge. Monitoring at this location provides a watershed-scale measure for remedial action effectiveness. The Bethel Valley watershed currently discharges to the Melton Valley watershed, where additional contaminants enter White Oak Creek before being discharged over White Oak Dam to the Clinch River.

Remediation criteria are specified in the Bethel Valley ROD for soils, floodplain sediments, and surface water. Remediation goals for surface water are to achieve Ambient Water Quality

Criteria (AWQC) in waters of the State of Tennessee, protect an off-site resident user of surface water, and protect the Clinch River to meet its stream use classification. Remediation of surface water sediment was deferred to a future decision. Remediation criteria for soils were derived to limit potential risk to a hypothetical future worker not to exceed 1 x $10^{-4}$ ELCR and HI≤3. In addition, remediation criteria are specified for unrestricted land use in the relatively undeveloped and non-impacted areas of Bethel Valley. These values are summarized in Table 4-3.

**Table 4-3. Soil Remediation Criteria from the Bethel Valley ROD**

| Principal COC in Soil | Selected Remediation Concentration for Industrial Worker | Selected Remediation Concentration for Unrestricted Areas |
|---|---|---|
| Carcinogens | | |
| Benz(a)anthracene | 260 mg/kg | 86 mg/kg |
| Benzo(a)pyrene | 26 mg/kg | 8.6 mg/kg |
| Benzo(b)fluoranthene | 250 mg/kg | 86 mg/kg |
| Dibenz(a,h)anthracene | 26 mg/kg | 8.6 mg/kg |
| N-nitroso-di-n-propylamine | - | 7.8 mg/kg |
| Cobalt-60 | 7.4 pCi/g | 4 pCi/g |
| Iodine-129 | 1400 pCi/g | - |
| Cesium-137+D | 14 pCi/g | 7 pCi/g |
| Europium-152 | 9.5 pCi/g | 5 pCi/g |
| Europium-154 | 11 pCi/g | 6 pCi/g |
| Europium-155 | 710 pCi/g | - |
| Lead-210+D | 270 pCi/g | - |
| Radium-226+D* | 3 pCi/g | 3 pCi/g |
| Radium-228+D* | 3 pCi/g | - |
| Thorium-228+D* | 3 pCi/g | - |
| Thorium-232+D* | 3 pCi/g | 3 pCi/g |
| Uranium-235+D | - | 37 pCi/g |
| Uranium-238+D | 310 pCi/g | 91 pCi/g |
| Plutonium-240 | 540 pCi/g | - |
| Americium-241 | 450 pCi/g | - |
| Noncarcinogens | | |
| Arsenic | 330 mg/kg | - |

*Criteria for the Radium-226 and Thorium-232 decay series are non-risk-based values, set at 3 pCi/g above site-specific background concentrations. All other criteria are risk-based concentrations for the protection of a hypothetical future worker, and include any contributions from background.

An exposure unit approach like that described previously for Melton Valley is used, where both an average remediation level (averaged across the exposure unit) and a maximum remediation level (not to be exceeded at any location) are specified for each contaminant of concern. Where multiple COCs are present within an exposure unit, a sum-of-the-ratios approach must be used to ensure that the cumulative risk to the future worker from all contaminants may not exceed 1 x $10^{-4}$ ELCR (excluding the radium and thorium decay series) and HI≤3.

Bethel Valley Current State:

Wastes in Bethel Valley resulted from nuclear reactors, radioisotope operations, particle accelerators, hot cell operations, physical, chemical and biological research, fuel chemical reprocessing research, analytical laboratories, and other research and development operations and support facilities. The major areas of contamination in Bethel Valley include:

- The ORNL Main Plant Area includes active and inactive facilities, four inactive research reactors, numerous underground waste tanks, miles of associated pipeline, surface impoundments and contaminated soils. Strontium-90 is a major contaminant associated with releases from surface impoundments. Contaminated soils have resulted from liquid waste transfer pipeline leaks and spills. Pipeline and tank leaks also have contributed to groundwater contamination. The Corehole 8 groundwater plume is contaminated with strontium-90 and uranium, which resulted from a broken pipe in the North Tank Farm. A major challenge for remediation of the Main Plant Area is the extensive underground network of tanks and pipelines used for radionuclide processing and waste treatment.
- Solid Waste Storage Area 3 was used for disposal of low-level and transuranic wastes. Seepage from this area flows into shallow groundwater and then to nearby surface water. Contaminants of concern for Waste Area Grouping 3 include cesium-137 and strontium-90.
- Radiologically contaminated surface soil poses a risk to workers. Some subsurface contaminated soil resulting from liquid low-level waste pipeline leaks and other sources may contribute to groundwater contamination. The sediment and floodplain soil associated with on-site creeks is contaminated with radionuclides and mercury.
- Groundwater contaminated with strontium-90 and mercury currently discharges to surface water.

The Baseline Risk Assessment (DOE 1999a) identified the following potentially unacceptable risks for the Bethel Valley watershed:

- Soil and Sediment Contamination – Concentrations of radionuclides in soils and sediments present unacceptable risk (>1 x $10^{-4}$ ELCR) to future workers, primarily via the direct external pathway. Cesium-137 is the predominant contaminant of concern, and other contributors include cobalt-60 and the thorium-232 decay series.
- Burial Ground Contamination – SWSA 3 and associated soils present unacceptable risk (>1 x $10^{-4}$ ELCR) to future industrial workers.
- Building and Facility Contamination – Contaminated buildings, tanks, pipelines, and other facilities, particularly in Central Bethel Valley, present an unacceptable risk (>1 x $10^{-4}$ ELCR) to future industrial workers.
- Surface Water Contamination – Contamination from Bethel Valley contributes to unacceptable levels of strontium-90 at White Oak Dam in Melton Valley. Surface water in First Creek exceeds 1 x $10^{-4}$ ELCR to future workers.

- Groundwater Contamination – Groundwater has been significantly impacted by past operations. Numerous contaminants (e.g., strontium-90, tritium, VOCs) exceed MCLs, although groundwater is not currently used for industrial or other purposes at Bethel Valley.
- Ecological Risks – Potentially unacceptable risks to aquatic and terrestrial biota also were identified. COCs include metals (primarily mercury) in surface water; metals, PCBs and PAHs in sediment; and radionuclides (primarily cesium-137) in soil.

Life-Cycle Baseline Plan for Bethel Valley:

Under the current baseline, certain actions with opportunities for high risk reduction in Bethel Valley would be completed by 2008:

- The Bethel Valley Groundwater Engineering Study will be conducted to identify sources of groundwater contamination.
- The Corehole 8 removal action will be completed, including removal of tank W-1A and surrounding contaminated soils for off-site disposal.
- Completion of the Corehole 8 Plume groundwater extraction will be implemented to minimize further impacts to groundwater and to protect surface water bodies from contaminated discharges. Four deep extraction wells will be installed to collect water from bedrock, and sumps will be installed near storm drain junction boxes to collect and treat contaminated shallow groundwater. Enhanced biodegradation will be implemented in East Bethel Valley to address a volatile organic compound plume.
- The removal and off-site disposal of contaminated sediments from the Surface Impoundments Operable Unit was completed in 2003. Radiologically contaminated sediments were removed from these four former surface impoundments under an interim ROD issued in 1997. Most of this waste was successfully disposed at the EMWMF resulting in a significant cost savings relative to the off-site disposal alternative previously planned.
- Fuel salts from the Molten Salt Reactor Experiment (MSRE) will be removed for off-site disposal.
- Resin beads will be removed from the T1, T2, and High Flux Isotope Reactor (HFIR) tanks and the tanks grouted in place.

The remainder of remedial actions in the Bethel Valley watershed would be completed by 2015, including the following:

- Inactive buildings/facilities will be demolished and the Graphite Reactor core will be stabilized.
- Soil will be removed above remediation levels established for worker protection to a maximum depth of 2 feet in the controlled industrial area, and soil will be removed above remediation levels established for worker protection to a maximum depth of 10 feet in the unrestricted industrial area.
- Solid Waste Storage Area 3 will be hydraulically isolated through capping.
- Institutional controls will be maintained in perpetuity to control future land use, to restrict access to capped waste disposal areas, and to prohibit onsite use of groundwater.

Risk-Based End State Vision for Bethel Valley:

Current baseline plans for Bethel Valley are designed to support the planned industrial end use of the ORNL site, and remediation criteria were derived to achieve an acceptably low level of risk to the future workers. The actions planned under the current baseline are considered to be generally consistent with remedial actions designed solely on the basis of the risk-based end state. No specific variances have been identified to date for Bethel Valley.

The remedy contained in the existing ROD for Bethel Valley is based on future use of portions of the site for DOE-controlled industrial use, other portions for uncontrolled industrial use, and still other portions for unrestricted use. Remediation criteria for each of these subareas are derived to limit the potential risk to a future industrial worker not to exceed $1 \times 10^{-4}$ ELCR and HI$\leq$3, and thus the remedy is considered RBES. However, since DOE plans to maintain ownership and control over the entire Bethel Valley watershed for the foreseeable future in support of the ongoing ORNL mission, the division of the site into these different land use categories may be unnecessary. If the end-use designation is changed in the future, the selected remedy should be reevaluated with respect to the RBES.

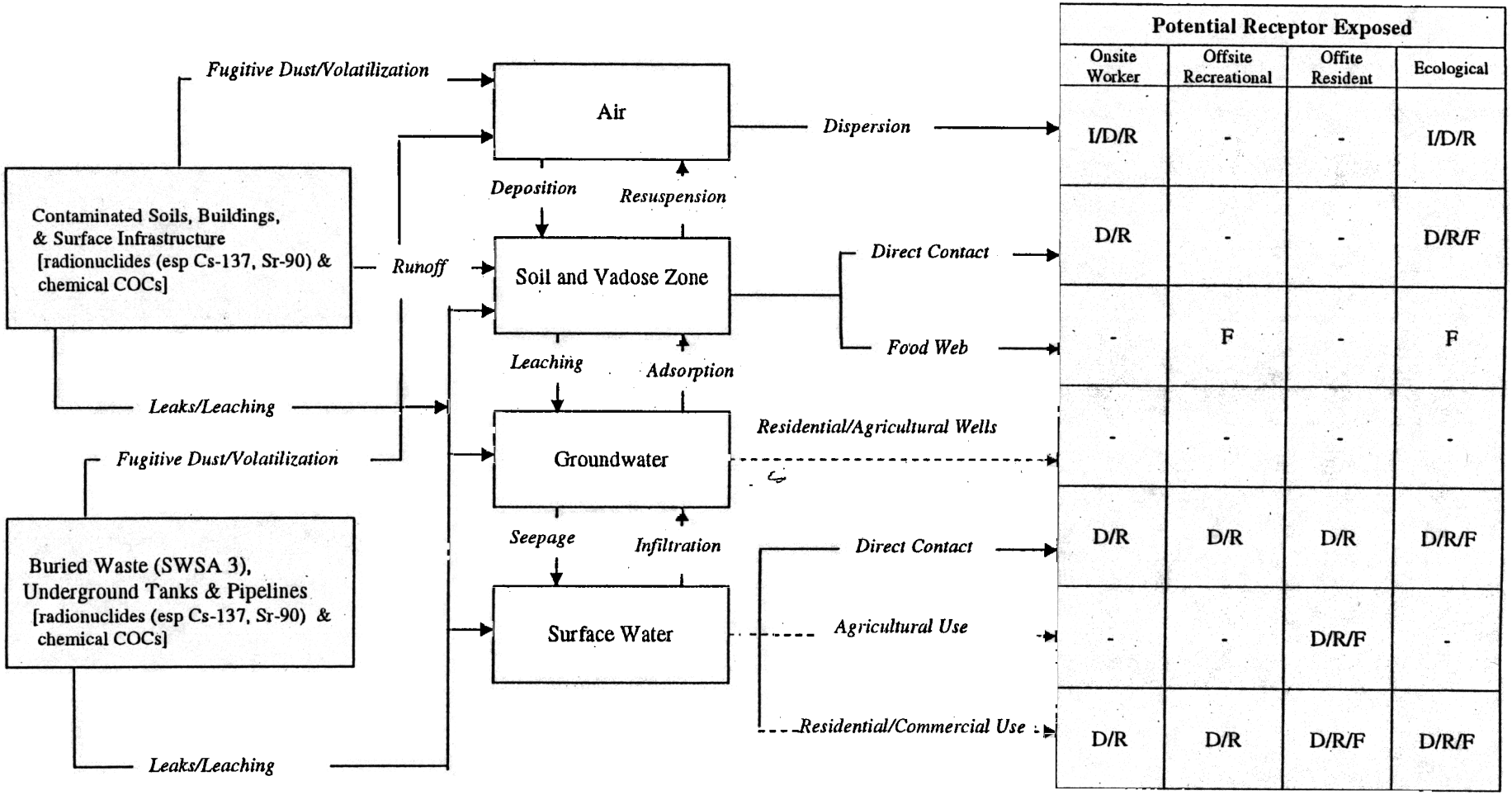
Maps of the Bethel Valley watershed under current and RBES conditions are provided in Figures 4.3a1 and 4.3.b1. Conceptual site models under current state and RBES conditions are illustrated in Figures 4.3a2 and 4.3b2, respectively.

The RBES scenario for Bethel Valley is considered to be identical to the current baseline. Contaminants in buildings, soil, and other materials above risk-based criteria for industrial use will be removed for off-site disposal. A long-term stewardship program will ensure the continuing protectiveness of the remedy, including continuing surveillance and maintenance. The containment system for the capped area at SWSA 3 will require periodic maintenance and repair to minimize the potential for failure. Groundwater monitoring wells will require periodic maintenance and replacement at longer intervals (assumed 30 years). Since contaminants will remain on site above levels suitable for unlimited use and unrestricted exposure, a statutory review will be conduct at least every five years to ensure that the remedy continues to be protective of human health and the environment.

*[Insert Figure 4.3.a1 – Hazard Area 3 (Bethel Valley) Map – Current State]*

*[Insert Figure 4.3.b1 – Hazard Area 3 (Bethel Valley) Map – RBES]*

*Figure 4.3a2, Conceptual Site Model - Hazard Area 3, Bethel Valley – Current State*




| Potential Receptor Exposed | | | |
|---|---|---|---|
| Onsite Worker | Offsite Recreational | Offite Resident | Ecological |
| I/D/R | - | - | I/D/R |
| D/R | - | - | D/R/F |
| - | F | - | F |
| - | - | - | - |
| D/R | D/R | D/R | D/R/F |
| - | - | D/R/F | - |
| D/R | D/R | D/R/F | D/R/F |

**KEY**

→ Active transport, uptake, or exposure pathway

⇢ Blocked or mitigated transport, uptake, or exposure pathway

I – Inhalation
D – Dermal contact R – Direct Radiation Exposure
F – Ingestion

*Figure 4.3a2, Conceptual Site Model - Hazard Area 3, Bethel Valley – Current State*

**Narrative:**

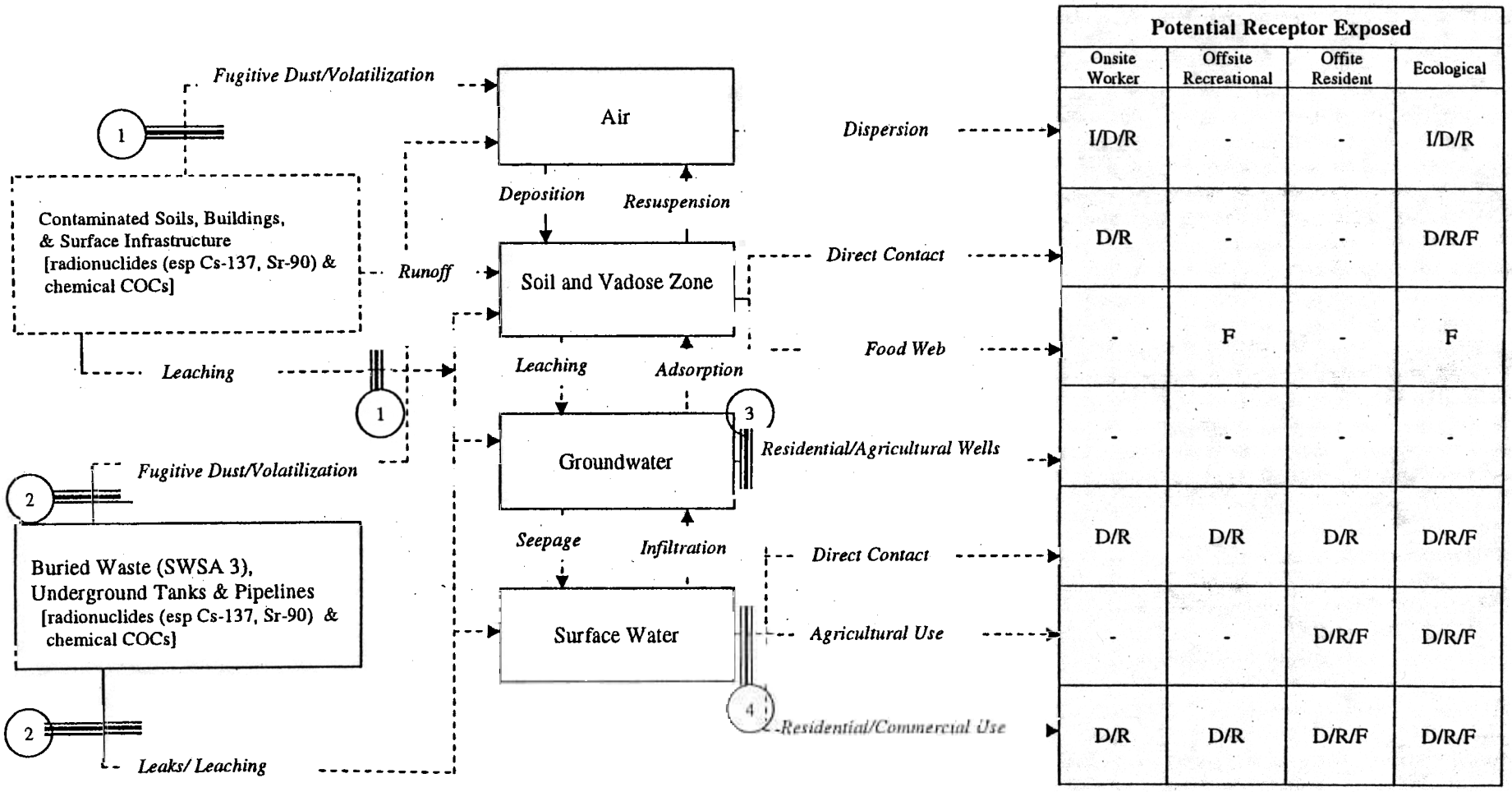
**Contaminant Sources:**

Bethel Valley includes the main industrial complex of Oak Ridge National Laboratory. Facility operations during the past 60 years have resulted in a large number of sites and facilities contaminated with a variety of radioactive and hazardous contaminants; contaminated sites include numerous buildings, tanks, surface impoundments, reactors, above- and below-ground pipelines and utilities, and buried waste sites. Contaminants of concern include numerous radionuclides and chemicals, particularly Cs-137 and Co-60 in soil and sediments, and Sr-90 in surface water. Under the existing CERCLA ROD approved in 2002, remediation criteria are specified for soils, floodplain sediment, and surface water, based on future industrial use of the site. Remediation criteria for contaminants of concern in soil were derived to limit risks to future industrial workers not to exceed $1 \times 10^{-4}$ ELCR and HI<3. Remediation goals for surface water are to achieve AWQC, to proctect an off-site resident user of surface water, and to protect the Clinch River to meet its stream use classification. Numerous contaminants (Sr-90, H-3, VOCs) in groundwater exceed MCLs, although there is no current use of groundwater at Bethel Valley. Institutional controls include restrictions on future groundwater and surface water use in Bethel Valley.

**Current State Exposure Pathways and Receptors:**

Under current conditions, potentially complete exposure pathways for onsite workers include: inhalation of resuspended particulates or volatiles; and direct exposure to contaminants in soils, waste and surface water. While Bethel Valley is not normally accessible to recreational users, potentially complete exposure pathways to off-site recreationists include direct contract with surface water and ingestion of fish. Ecological receptors potentially may be exposed to contaminants in air, soil, surface water and the food chain. Surface water in Bethel Valley enters White Oak Creek and flows through Melton Valley to White Oak Lake, where it exits the ORR. Potentially complete exposure pathways to offsite residents include direct contact with surface water after exiting the ORR, fish ingestion, and use of surface water for irrigation of home gardens. There is no current use of groundwater or surface water in Bethel Valley for residential, commercial, or agricultural purposes.

*Figure 4.3b2, Conceptual Site Model – Hazard Area 3, Bethel Valley – RBES*




| Potential Receptor Exposed | | | |
|---|---|---|---|
| Onsite Worker | Offsite Recreational | Offite Resident | Ecological |
| I/D/R | - | - | I/D/R |
| D/R | - | - | D/R/F |
| - | F | - | F |
| - | - | - | - |
| D/R | D/R | D/R | D/R/F |
| - | - | D/R/F | D/R/F |
| D/R | D/R | D/R/F | D/R/F |

**KEY**

Active transport, uptake, or exposure pathway

Blocked or mitigated transport, uptake, or exposure pathway

Engineered barrier or administrative control – sequentially numbered

I – Inhalation
D – Dermal contact R – Direct Radiation Exposure
F – Ingestion

*Figure 4.3b2, Conceptual Site Model – Hazard Area 3, Bethel Valley – RBES*

**Narrative:**

**Contaminant Sources:**

Under both current life-cycle baseline and Risk-Based End State conditions, the Bethel Valley watershed will continue to be used for the operation of Oak Ridge National Laboratory, i.e. DOE-controlled industrial use. Contaminants of concern include Cs-137 and Co-60 in soil and sediments, and Sr-90 in surface water. Remediation criteria for contaminants of concern in soil and other media were derived tolimit risks to the future industrial workers not to exceed $1 \times 10^{-4}$ ELCR and HI<3. Institional controls include restrictions on access to the waste management areas and restrictions on future groundwater and surface water use throughout Bethel Valley.

**Risk-Based End State Barriers/Interventions:**

The steps taken to mitigate or remove these hazards are as follows:

1. Contaminated buildings and soils within Bethel Valley will be remediated such that contaminants of concern do not exceed risk-based remediation criteria for industrial use. Contaminated media above remediation criteria generally will be removed for disposal at the EMWMF disposal facility. Inactive buildings and facilities will be demolished and removed. Residual contaminant levels will be below levels of concern for fugitive dust emissions/volatilization or direct radiation exposure. While the ROD specifies that soil will be remediated to a depth of 2 ft in some areas and 10 ft in others, under the RBES conditions, the depth of soil remediation is taken to be 2 ft throughout Bethel Valley.

2. Most underground tanks and pipelines will be contained in place via grouting , use of cover systems and other hydraulic controls. The SWSA 3 burial ground will be hydraulically isolated via installation of a multi-layer engineered cover system. The engineered containment systems will preclude unacceptable exposures to workers or releases of contaminants to the environment above levels of concern. Institutional controls will be maintained in perpetuity to restrict access to the grouted or capped sites.

3. Future land use within Bethel Valley will be restricted to industrial use, and institutional controls will prohibit groundwater use. The ongoing groundwater extraction project for the Corehole 8 Plume will be completed to minimize further impacts to groundwater and to protect surface water from contaminated discharges. Long-term stewardship and institutional controls will ensure continuing protectiveness of the remedy. Surveillance and maintenance will include monitoring of surface water and groundwater, with periodic maintenance and replacement of groundwater wells and ongoing maintenance of capped areas as required.

4. As noted in the discussion for Melton Valley, remediation of surface water and sediment in White Oak Creek has been generally deferred to a future CERCLA decision. It is anticipated that the actions described in items 1 and 2 above, along with other remedial actions for Bethel Valley, will significantly reduce the flux of contaminants into surface water of White Oak Creek and White Oak Lake, which are ultimately discharged to the Clinch River upon exiting the ORR. Institutional controls include restrictions on current use of surface water within Bethel Valley.

## 4.4 Hazard Area 4 - Upper East Fork Poplar Creek

The Upper East Fork Poplar Creek (UEFPC) watershed, which includes the main industrial area of the Y-12 National Security Complex, is located between Pine Ridge and Chestnut Ridge in the northeast corner of the Oak Ridge Reservation and includes approximately 1170 acres. The boundaries of the UEFPC watershed extend along the top of Pine Ridge to the north, the top of Chestnut Ridge to the south, the eastern boundary of the Bear Creek Valley watershed to the west, and the DOE-ORR property boundary (Scarboro Road) to the east. UEFPC also includes a contaminated groundwater plume (the Y-12 Plant East End VOC Plume) that extends beyond the DOE-ORR property boundary to the east into Union Valley, where it terminates at springs and headwaters of Scarboro Creek located near Illinois Avenue. The headwaters of Upper East Fork Poplar Creek are near the S-3 Ponds. When the Y-12 Plant was built, the creek was rerouted through storm drains and its original tributaries were backfilled. The creek exits the ORR at Station 17 at the eastern boundary of the UEFPC watershed.

The Y-12 National Security Complex occupies approximately 800 acres near the northeastern corner of the ORR, adjacent to the city of Oak Ridge. Y-12's original mission was to chemically separate and produce fissile uranium-235 from uranium-238 using an electromagnetic separations process (alpha process) and to manufacture weapons components as part of the national effort to produce the atomic bomb. As other uranium enrichment processes were developed and implemented at other installations, the role of Y-12 expanded to include weapon components manufacturing and precision machining, research and development, lithium isotope separation, and special nuclear materials storage and management. Y-12 continues to be operated by the National Nuclear Security Administration (NNSA) as an active manufacturing and developmental engineering facility. Its current mission includes the manufacturing and reworking of nuclear weapons components, dismantling nuclear weapons components, serving as the nation's stockpile for special nuclear materials, and providing special production support to other programs. More than 50% of the facilities currently in use at the Y-12 site are now more than 50 years old, and the site is undertaking a major modernization program.

It should be noted that the end-state land use at UEFPC assumed under both the current lifecycle baseline and the RBES conditions differs somewhat from the recommendations of the EUWG. The EUWG recommended that the future land use at Y-12 should be DOE/NNSA-controlled industrial use within the western and south-central portions of the complex, and unrestricted industrial use in the eastern and north-central plant areas. However, the NNSA has since determined that because of security concerns and the current modernization program, the anticipated land use for the foreseeable future will be DOE/NNSA-controlled industrial use throughout the entire Y-12 complex.

Remediation of the UEFPC watershed is being conducted in stages using a phased approach. The *Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area* (DOE 2002c), issued in May 2002, constitutes the initial phase and addresses interim actions for remediation of principal-threat mercury-contaminated soil, sediment, and point groundwater discharges that contribute contamination to surface water. This

initial ROD did not address active facilities or waste management areas. Remedial actions include hydraulic isolation, soils/sediment removal, water treatment, monitoring, and land use controls. The second phase of remediation is focused on actions for the remediation of the balance of contaminated soil, scrap, and buried materials in the Y-12 main industrial complex, the major area of contamination in the UEFPC watershed. The initial draft of the *Upper East Fork Poplar Creek Soil Focused Feasibility Study* (DOE 2003d) was released in July 2003. In addition, a final surface water ROD is expected to be issued in the future.

The remedial action objective for the actions under the initial ROD is to restore mercury concentrations in surface water to risk-based (human health) levels for recreational use at Station 17 (the point where UEFPC exits the ORR). The mercury concentration limit of 200 ppt in UEFPC surface water was derived to limit the risk to potential receptors from the fish ingestion pathway.

Remediation levels for contaminants of concern in soil and sediment are currently under development. The draft Focused Feasibility Study (DOE 2003d) presents remediation criteria derived to limit risk to a future worker not to exceed $1 \times 10^{-4}$ ELCR and HI $\leq 3$ for DOE/NNSA-controlled industrial land use. An exposure unit approach is used, which establishes an average remediation level across an exposure unit that will not be exceeded and a maximum remediation level not to be exceeded at any location. Contaminated soil in an EU will be remediated so that the residual concentration averaged across the exposure unit will be at or below the corresponding average remediation level, and the maximum contaminant concentration found at any location will be at or below the corresponding maximum remediation level. Contaminants of concern include uranium, mercury, radium-226, thorium-232, cesium-137, cadmium, and PCBs. In addition to the remediation levels for individual contaminants of concern, the cumulative risk to the future worker from all contaminants may not exceed $1 \times 10^{-4}$ ELCR and HI$\leq$3.

**Table 4-4. Draft Soil Remediation Criteria from the UEFPC Focused Feasibility Study**

| Target COC in Soil | Proposed Remediation Concentration |
|---|---|
| Carcinogens | |
| Cesium-137 | 11 pCi/g |
| Radium-226+D | 6 pCi/g * |
| Thorium-232+D | 8 pCi/g * |
| Uranium-235+D | 12 pCi/g |
| Uranium-238+D | 50 pCi/g |
| PCB | 10 mg/kg |
| Noncarcinogens | |
| Cadmium | 30 mg/kg |
| Mercury | 325 mg/kg |
| Uranium | 1150 mg/kg |

*Criteria for radium-226+D and thorium-232+D are non-risk-based values, set at 5 pCi/g above the site-specific background concentrations of 1.4 pCi/g and 2.75 pCi/g, respectively. All other criteria are risk-based for the protection of a hypothetical future worker under DOE/NNSA-controlled industrial use.

In addition to the risk-based criteria for protection of the industrial worker summarized in Table 4-4, the draft Focused Feasibility Study also specifies remedial action objectives to remediate any soils determined to be contributing to groundwater contamination that exceeds 1 x $10^{-4}$ ELCR for an industrial drinking water scenario, and any soils determined to be contributing to surface water contamination by mercury exceeding the 200 ppt criterion in the Phase I ROD.

UEFPC Current State:

More than 70 sources of contamination have been identified within the Upper East Fork Poplar Creek watershed. The major sources include:

- The area contains an almost continuous nitrate- and uranium-238 contaminated groundwater plume, which originates from the S-3 Ponds and other sources within the plant. This plume, located deep in bedrock (300 to 400 feet), has migrated 400 feet down and 4000 feet laterally from its sources. It also contains other radionuclides and metals.
- A carbon tetrachloride-contaminated groundwater plume exists in the east end of the site and extends off site under the Union Valley Industrial Park. The source of this plume is unknown; however, carbon tetrachloride was used in large amounts from 1943 to 1946 in processing source material for the electromagnetic separation process. An early action for collection and treatment of this East End VOC Plume is ongoing to control migration.
- Upper East Fork Poplar Creek surface water and sediments are contaminated with mercury from groundwater discharge and overland flow.
- Two ponds have been used to handle contaminated surface water exiting the Y-12 National Security Complex prior to entering Lower East Fork Poplar Creek. These ponds concentrated mercury and other contaminants in sediments. New Hope Pond was closed under the Resource Conservation and Recovery Act but may still be contributing to groundwater contamination.
- A scrap yard has been used since the early 1970s to receive scrap metal from plant operations. Some of the scrap deposited here is contaminated with radioactive materials, primarily depleted uranium and uranium-235.
- The Alpha 4 building is contaminated with mercury from historical operations.

The Baseline Risk Assessment (DOE 1998b) identified the following potentially unacceptable risks for the UEFPC watershed:

- Sediment Contamination - Mercury, PCBs, and other COCs in sediments of UEFPC present unacceptable risk (>1 x $10^{-4}$ ELCR) to a future recreational receptor via the dermal exposure pathway.
- Surface Water Contamination – Mercury in UEFPC surface water exceeds AWQC (51 ppt) and risk-based levels for ingestion of fish by recreational receptors (200 ppt).
- Soil Contamination – Radionuclide and PCB levels in contaminated soil at the Y-12 site exceed risk-based levels for industrial workers, which would present an unacceptable risk (>1 x $10^{-4}$ ELCR) to workers in the absence of current controls.

- Groundwater Contamination – VOC contamination in groundwater exceeds MCLs and acceptable risk levels (>1 x $10^{-4}$ ELCR) for the future industrial worker onsite and the future residential receptor offsite.

Life-Cycle Baseline for UEFPC:

Under the current baseline, certain actions with opportunities for high risk reduction in UEFPC would be completed by 2008:

- Installation of the Building 9201-2 Water Treatment System to mitigate off-site release of mercury via surface water releases to UEFPC.
- Bioremediation to mitigate the offsite East End VOC Plume. This bioremediation treatment would be used to enhance or replace the ex-situ pump-and-treat technology that has been in operation at this site since 2000 to reduce carbon tetrachloride concentrations.

The remainder of remedial actions in the UEFPC watershed would be completed by 2015, including the following:

- Alpha 4 and unneeded waste management facilities will be demolished.
- Mercury- and PCB-contaminated soil and sediment will be excavated, and subsurface contamination beneath process buildings will be hydraulically isolated.
- Groundwater exiting the facility will be collected and treated in above-ground treatment facilities or in-situ.
- The offsite VOC plume in Union Valley will be managed with institutional controls.
- Contaminated scrap metal will be removed.
- Soils containing contaminants of concern above risk-based levels will be removed.
- Institutional controls will be maintained in perpetuity to control future land use, to restrict access to soils below the depth of remediation, and to prohibit onsite use of groundwater.

Risk-Based End State Vision for UEFPC:

The Y-12 National Security Complex is expected to continue operations for the foreseeable future in support of national security needs. Current baseline plans for UEFPC are designed to support the planned DOC/NNSA-controlled industrial use of the Y-12 site, and remediation criteria are being derived to achieve an acceptably low level of risk to the future workers. The Phase I ROD for UEFPC only addresses release of mercury in surface water exiting the ORR, and remedial action planning for other areas of concern is only in a developmental stage. These actions will be designed to build on previous interim measures, including RCRA closures of the S-3 Ponds, New Hope Pond and other facilities, and the ongoing groundwater treatment operations to control the migration of an offsite VOC plume. Actions planned under the current baseline are considered to be consistent with remedial actions designed solely on the basis of the risk-based end state, and no specific variances have been identified to date.

Under the current baseline plan, soil and sediment in the UEFPC watershed is expected to be remediated to a maximum depth of 2 feet to risk-based criteria derived to limit the potential risk to a future industrial worker not to exceed 1 x $10^{-4}$ ELCR and HI≤3. Source control measures currently being implemented under the Phase I ROD to reduce the release of mercury in surface water exiting the ORR include hydraulic isolation on mercury-contaminated areas, removal of contaminated sediments from UEFPC and Lake Reality, groundwater treatment, monitoring, and land use controls. The current pump-and-treat system for controlling the spread of the East End VOC Plume is planned to be replaced by a passive in-situ bioremediation system. While the concentration of carbon tetrachloride in the off-site groundwater plume exceeds levels that present an unacceptable future risk to an offsite industrial or residential receptor using groundwater as a drinking water source in the Union Valley area, there is no current use of groundwater at this location. The protection of surface water and groundwater to risk-based levels are also identified as remedial action objectives for the proposed soil action.

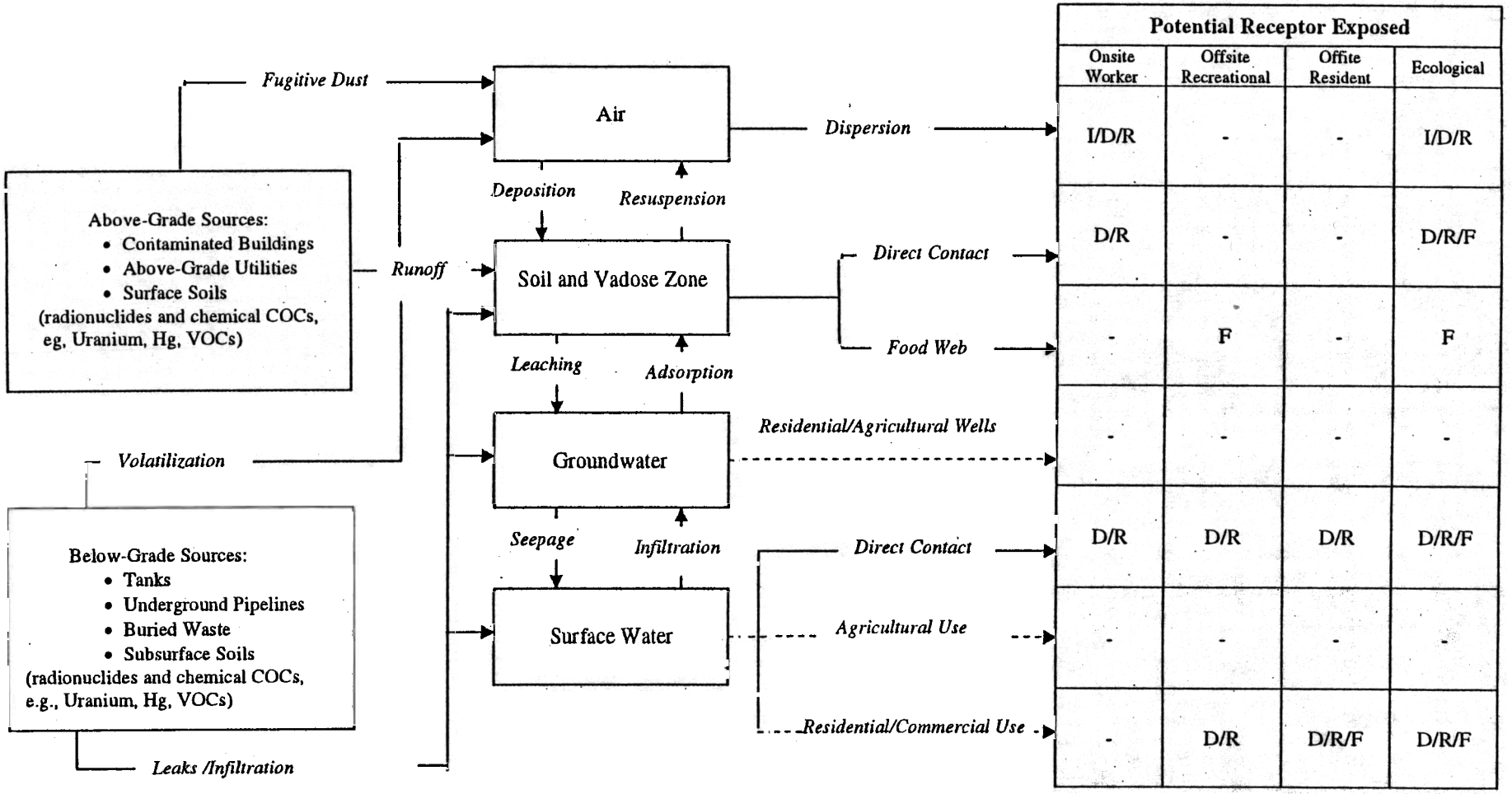
Maps of the UEFPC under current and RBES conditions are provided in Figures 4.4a1 and 4.4.b1. Conceptual site models under current state and RBES conditions are illustrated in Figures 4.4a2 and 4.4b2, respectively.

The RBES remediation scenario for UEFPC is considered identical to the current baseline. Buildings, soils and other materials containing contaminants above risk-based criteria for future industrial use will be removed from the site for off-site disposal. A long-term stewardship program will ensure the continuing protectiveness of the remedy, including continuing surveillance and maintenance. Groundwater monitoring wells will require periodic maintenance and replacement at longer intervals (assumed 30 years). The passive in-situ bioremediation treatment system for the East End VOC plume is expected to require less maintenance than the current pump-and-treat system. Since contaminants will remain on site above levels suitable for unlimited use and unrestricted exposure, a statutory review will be conduct at least every five years to ensure that the remedy continues to be protective of human health and the environment.

*[Insert Figure 4.4.a1 – Hazard Area 4 (UEFPC) Map – Current State]*

*[Insert Figure 4.4.b1 – Hazard Area 4 (UEFPC) Map – RBES]*

*Figure 4.4a2, Conceptual Site Model - Hazard Area 4, Upper East Fork Poplar Creek – Current State*




| Potential Receptor Exposed | | | |
|---|---|---|---|
| Onsite Worker | Offsite Recreational | Offite Resident | Ecological |
| I/D/R | - | - | I/D/R |
| D/R | - | - | D/R/F |
| - | F | - | F |
| - | - | - | - |
| D/R | D/R | D/R | D/R/F |
| - | - | - | - |
| - | D/R | D/R/F | D/R/F |

**KEY**

→ Active transport, uptake, or exposure pathway

⇢ Blocked or mitigated transport, uptake, or exposure pathway

I – Inhalation
D – Dermal contact R – Direct Radiation Exposure
F – Ingestion

*Figure 4.4a2, Conceptual Site Model - Hazard Area 4, Upper East Fork Poplar Creek – Current State*

**Narrative:**

**Contaminant Sources:**

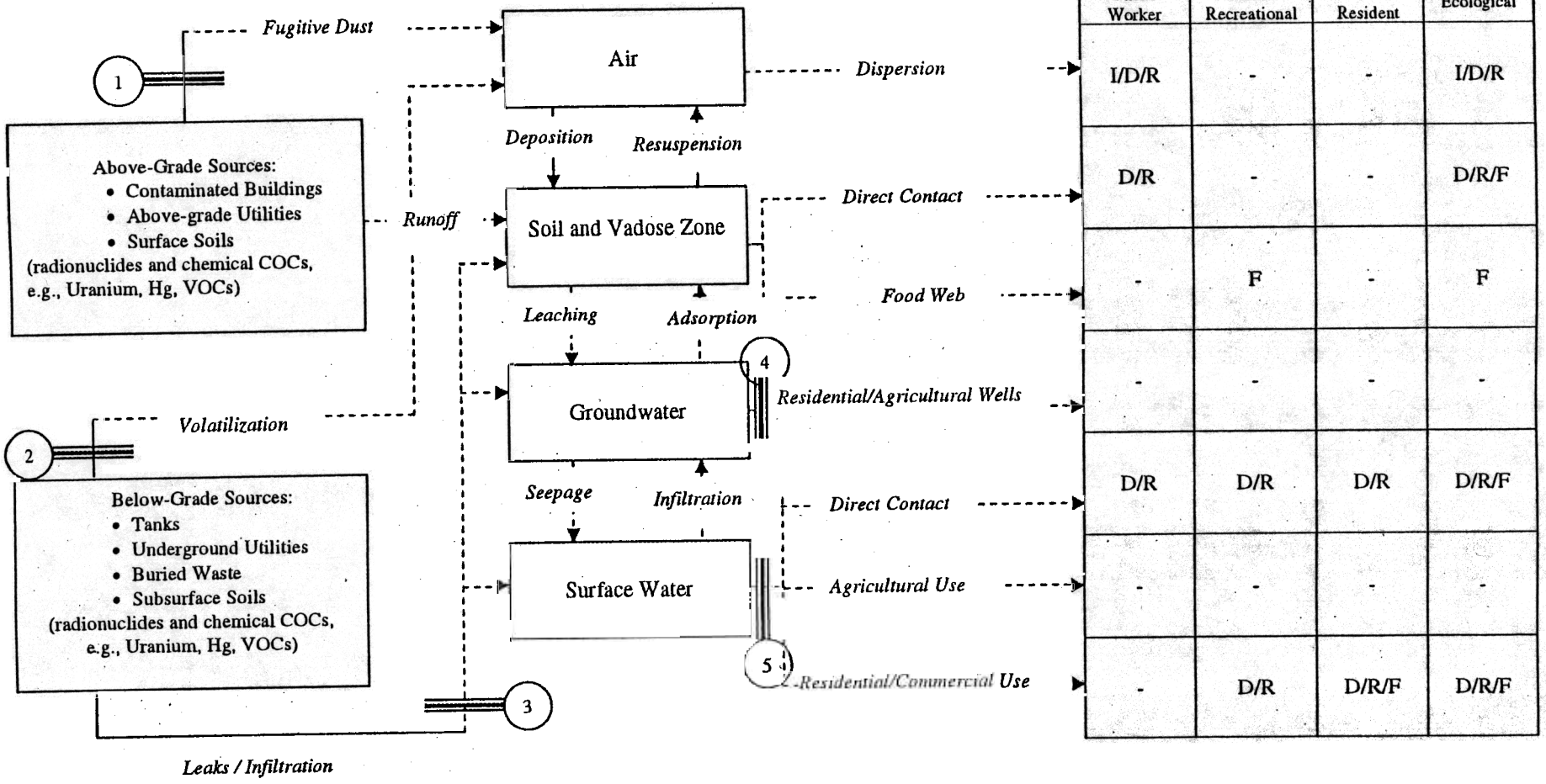
Hazard Area 4, Upper East Fork Poplar Creek, includes the main industrial complex of the Y-12 National Security Complex. This is a major industrial complex with hundreds of large buildings and an extensive industrial infrastructure of roadways, pipelines, and other utilities. Site operations during the past 60 years have included a number of manufacturing and machining operations involving a variety of hazardous materials, including uranium, mercury, beryllium, and VOCs. Y-12 remains an active facility with an important current and future mission in support of national security, and is currently embarking on a major modernization program to replace aging buildings and infrastructure.

Under current state conditions, numerous buildings, above- and below-grade pipelines and other utilities, tanks, soils and buried wastes contain contaminants of concern in concentrations above preliminary site remediation levels (the CERCLA decision documents to determine remediation criteria are currently under development). While remediation criteria are not yet finalized, they are expected to be risk-based values, derived to protect the future industrial worker at the Y-12 facility. Contaminants of concern include radionuclides (primarily uranium), Hg and other metals, and VOCs.

**Current State Exposure Pathways and Receptors:**

Under current conditions, potentially complete exposure pathways for onsite workers include: inhalation of particulates or volatiles; and direct exposure to contaminants in soils, buildings/structures, waste and surface water. Potentially complete exposure pathways to off-site recreationists include direct contract with surface water and ingestion of fish. Ecological receptors potentially may be exposed to contaminants in air, soil, surface water and the food chain. The Upper East Fork Poplar Creek enters the Lower East Fork Poplar Creek upon exiting the ORR and continues flow through the city of Oak Ridge; potentially complete exposure pathways to offsite residents include direct contact with surface water, fish ingestion, and use of contaminated surface water for irrigation of home gardens. There is no current use of groundwater at UEFPC for residential, commercial, or agricultural purposes. A VOC groundwater plume extends offiste east from the Y-12 site into the Union Valley area, containing levels of carbon tetrachloride that present an unacceptable risk to a hypothetical offsite residential or industrial receptor obtaining drinking water from this source; however, there is no current use of this groundwater, so this potential exposure pathway is not complete.

*Figure 4.4b2, Conceptual Site Model – Hazard Area 4, Upper East Fork Poplar Creek – RBES*




| Potential Receptor Exposed | | | |
|---|---|---|---|
| Onsite Worker | Offsite Recreational | Offite Resident | Ecological |
| I/D/R | - | - | I/D/R |
| D/R | - | - | D/R/F |
| - | F | - | F |
| - | - | - | - |
| D/R | D/R | D/R | D/R/F |
| - | - | - | - |
| - | D/R | D/R/F | D/R/F |

**KEY**

Active transport, uptake, or exposure pathway

Blocked or mitigated transport, uptake, or exposure pathway

Engineered barrier or administrative control – sequentially numbered

I – Inhalation
D – Dermal contact R – Direct Radiation Exposure
F – Ingestion

*Figure 4.4b2, Conceptual Site Model – Hazard Area 4, Upper East Fork Poplar Creek – RBES*

**Narrative:**

**Contaminant Sources:**

Under both current life-cycle baseline and Risk-Based End State conditions, the Upper East Fork Poplar Creek watershed will remain under DOE/NNSA control as the operations of the Y-12 National Security Complex continue for the foreseeable future. All buildings, pipelines and other utilities, soils, and other sources containing contaminants above remediation critieria derived for DOE/NNSA industrial use will be remediated. Residual contamination below the risk-based remediation criteria will remain in soils, sediments, surface water and groundwater, that will preclude unrestricted use of the site but will not pose unacceptable risk to future DOE/NNSA industrial workers. Institional controls will include restrictions on future groundwater use.

**Risk-Based End State Barriers/Interventions:**

The steps taken to mitigate or remove these hazards are as follows:

1. Contaminant levels in buildings, utilities and soils will be reduced below risk-based remediation criteria. While remedial actions and criteria have yet to be finalized in the ROD, soils and sediments in the UEFPC watershed are expected to be remediated to a maximum depth of 2 ft to risk-based criteria designed to limit the potential risk to the future DOE/NNSA worker not to exceed 1 x 10-4 ELCR and HI<3. Residual contaminant levels will be below levels of concern for fugitive dust emissions and direct radiation exposure.

2. Contamination above risk-based remediation levels in tanks, below-grade pipelines and utilities, and soils will be removed for offsite disposal, eliminating potential for airborne emissions. Buried wastes would be excavated for offsite disposal or contained in place via capping. Residual contamination levels also will be below levels of concern for direct radiation exposure.

3. Remediation of contamination above risk-based remediation levels in tanks, below-grade pipelines and utilities, soils, and buried waste will eliminate potential for continuing releases to surface water or groundwater. Residual contamination levels also will be below levels of concern for direct radiation exposure.

4. Future land use is restricted to DOE/NNSA-controlled industrial use, with prohibitions on onsite use of groundwater. A VOC plume extends offsite to the east of the Y-12 site into the Union Valley area. The pump-and-treat system currently in place to contain this plume will be replaced by an in-situ bioremediation treatment system. Long-term stewardship and institutional controls will ensure continuing protectiveness of the remedy. Surveillance and maintenance will include monitoring of surface water and groundwater, with periodic maintenance and replacement of groundwater wells and ongoing maintenance of capped areas as required.

5. Actions under the Phase I ROD are designed to reduce the release of Hg in surface water exiting the ORR; these actions include hydraulic isolation of mercury-contaminated areas, removal of contaminated sediments from UEFPC and Lake Reality, groundwater treatment, monitoring, and land use controls.

## 4.5 Hazard Area 5 - Bear Creek Valley

Bear Creek Valley is approximately 10 miles long and extends from the eastern end of the Y-12 National Security Complex to the Clinch River on the west. The Bear Creek Valley watershed extends from the western boundary of the Y-12 complex to just west of state Highway 95, covering an area of approximately 1,000 acres. The watershed is bounded on the south by the Bethel Valley watershed, to the north by Pine Ridge and the City of Oak Ridge, and on the east by the Upper East Fork Poplar Creek watershed.

A 2-mile section of Bear Creek Valley immediately west of the Y-12 Plant includes several waste disposal facilities formerly used for disposal of radioactive and hazardous wastes generated from operations at Y-12 and throughout the ORR. These include: (1) the S-3 Site (including the S-3 Ponds); (2) the Oil Landfarm Area (including Oil Landfarm, Sanitary Landfill-1, the Boneyard/Burnyard, Hazardous Chemicals Disposal Area, and the Oil Landfarm Soils Containment Pad); and (3) the Bear Creek Burial Grounds, including numerous disposal pits and the DARA Solids Storage Facility. None of the sites are currently active, and all have either been capped with an engineered multi-layer cap or have a soil cover. A leachate collection system has been installed at the Bear Creek Burial Grounds to collect leachate at several seeps that have subsequently developed. Water from the waste areas flows into Bear Creek. A groundwater divide exists at the S-3 Ponds, where surface and groundwater flow east into the Upper East Fork Poplar Creek watershed and west into the Bear Creek Valley watershed. The flow of Bear Creek is closely related to groundwater flow, and during rain events groundwater discharges to the creek and its tributaries.

The Remedial Investigation Report (DOE 1997b) provides an extensive delineation of the nature and extent of contamination within the Bear Creek Valley watershed. The RI report is supplemented by a recent, more detailed study of the Boneyard/Burnyard (DOE 1998b). COCs identified as posing environmental hazards due to migration from the disposal areas include nitrate, uranium, cadmium, and VOCs migrating through groundwater and surface water downgradient from the S-3 Site, uranium and mercury migrating from the Boneyard/Burnyard, and uranium and VOCs migrating out of the Bear Creek Burial Grounds via groundwater and surface water. In addition, DNAPLs occur at the S-3 Site and the Bear Creek Burial Grounds; at these locations, DNAPLs are separated from the original source and have migrated along bedding planes and fractures in the Nolichucky shale. This migration has occurred to significant depth (400 ft) and resulted in dispersed droplets of DNAPLs left in fractures.

The *Record of Decision for Phase I Actions in Bear Creek Valley* (DOE 2001) was issued in September 2001. Remedial actions were selected in this ROD to significantly reduce the release of contaminants from these waste areas into Bear Creek and its tributaries and to mitigate ecological and human health hazards from contaminated media within the Bear Creek Valley watershed. Remedy selections for the Bear Creek Burial Grounds waste units, S-3 Ponds Site Pathways 1 and 2, and final groundwater cleanup requirements for Bear Creek Valley were not included in the Phase I ROD, but were deferred to future CERCLA decision documents.

Actions under the Phase I ROD included the removal of primary source areas at the Boneyard/Burnyard, which was estimated to be the greatest contributor to uranium flux into Bear Creek, and hydraulic isolation of the remainder of this site. Remedial actions at the Boneyard/Burnyard were completed in 2002, and appear to be successful in reducing uranium flux to the creek. The Phase I ROD did not specify any concentration limits for contaminants in soil, but prescribed excavation of certain waste disposal areas based on physical boundaries. The selected remedy was designed to reduce the total mass of contaminants migrating from source areas to Bear Creek and its tributaries, and to limit the risk to hypothetical downstream users of surface water from Bear Creek not to exceed $1 \times 10^{-5}$ ELCR. A Phase 2 ROD is planned to address contaminated materials in the Bear Creek Burial Ground, and a Phase 3 ROD is planned to document decisions for remediation of groundwater.

Bear Creek Valley Current State:

The main contaminant sources in Bear Creek Valley include:

- The S-3 Ponds were used from the 1950s to 1980s for disposal of more than 2 million gallons of nitric acid solution per year resulting in a nitrate- and uranium-contaminated groundwater plume that has migrated about 3000 feet from the ponds and impacts Bear Creek. The S-3 Ponds were closed under the Resource Conservation and Recovery Act. The Phase I ROD included actions to remediate shallow groundwater emanating from the S-3 Ponds (designated Pathway 3), while other potential groundwater pathways would be addressed under a future decision.
- The Oil Landfarm Area consists of the Oil Landfarm, Sanitary Landfill 1, and the Boneyard/Burnyard, with the Hazardous Chemicals Disposal Area located on top of the Boneyard/Burnyard. The Oil Landfarm was used to dispose of organic wastes; main current contaminants are uranium, beryllium, and PCBs. Groundwater is contaminated with low levels of volatile organic compounds. Little information exists about the types of waste disposed of at the Sanitary Landfill, which has been closed and covered with a clay and soil cap. At the Boneyard/Burnyard contaminated debris and wastes were buried in trenches. Contaminants, primarily uranium and to a lesser extent volatile organic compounds, flowed from the Boneyard/Burnyard into North Tributary 3. Remediation of the Boneyard/Burnyard was completed in 2002, and included excavation of approximately 80,000 $yd^3$ of contaminated wastes and hydraulic isolation of areas of low-level contamination.
- The Bear Creek Burial Grounds were used from the 1950s to the 1980s as the main solid waste disposal area for the Y-12 National Security Complex. Wastes were buried in trenches and covered with dirt. The main contaminants are uranium, thorium, beryllium and volatile organic compounds. The Walk-In Pits area was used for disposal of shock-sensitive and pyrophoric materials.
- Shallow groundwater in the eastern end of Bear Creek Valley is contaminated with uranium and dense non-aqueous phase liquids (DNAPLs). Deep groundwater is also contaminated with dense non-aqueous phase liquids. This groundwater contamination impacts surface water in the valley.

While not considered a source area for purposes of remedial action planning in Bear Creek Valley, another facility of major significance in this watershed is the Environmental Management Waste Management Facility. This facility was authorized under the *Record of Decision for the Disposal of Oak Ridge Reservation Comprehensive Environmental Response, Compensation, and Liability Act of 1980 Waste* (DOE1999b) for the disposal of wastes from ORR cleanup actions.

The White Wing Scrap Yard (WWSY, formerly identified as ORNL WAG 11) is located in the western portion of Bear Creek Valley. WWSY was used as a storage area for scrap and debris from ORNL, Y-12, and ETTP. Material disposed at this site included steel tanks, metal, glass, concrete, and miscellaneous industrial trash contaminated with radiological materials. Above-ground scrap and debris has been removed from the site under a series of interim measures, including the 1992 *Interim Record of Decision for the Oak Ridge National Laboratory, Waste Area Grouping 11, Surface Debris* (DOE 1992). Remediation requirements for remaining soil and other materials containing contaminants of concern above risk-based levels will be determined under a future CERCLA decision.

Life-Cycle Baseline for Bear Creek Valley:

Under the current baseline, near-term opportunities for major risk reduction in Bear Creek Valley include the hydraulic isolation and removal of hot spots from the Boneyard/Burnyard, which was completed in 2002. Baseline plans for other remedial actions in Bear Creek Valley, which are scheduled to be completed by 2015 under future CERCLA RODs, include the following:

- Planned actions at the Bear Creek Burial Grounds include hydraulic isolation through capping, diversion trenches, and in-situ treatment of high risk waste.
- Contaminated groundwater from the S-3 Pond seeps will be collected and treated in-situ. Groundwater actions are expected to include monitored natural attenuation.
- Contaminated soil exceeding risk-based criteria will be excavated.
- Institutional controls will be maintained in perpetuity to control future land use, to restrict access to capped waste disposal areas, and to prohibit onsite use of groundwater.

Risk-Based End State Vision for Bear Creek Valley:

Current baseline plans for Bear Creek Valley are designed to support the planned industrial end use of the site, and remediation criteria were derived to achieve an acceptably low level of risk to the future workers. Therefore, the actions planned under the current baseline are considered to be generally consistent with remedial actions designed solely on the basis of the risk-based end state. No specific variances have been identified to date for Bear Creek Valley.

Remedial actions selected under the Phase I ROD were limited to source reduction actions designed to reduce the overall flux of contaminants into Bear Creek in order to limit the potential risk to hypothetical downstream users of surface water from Bear Creek not to exceed $1 \times 10^{-5}$ ELCR and also to attain AWQC. This remedy identified three zones within Bear Creek Valley, each with a different future land use: Zone 1, the western portion of the watershed most distant

from the Y-12 site, was considered suitable for unrestricted use; Zone 2, the middle portion of the watershed was restricted to recreational use and serves as a buffer zone between Zones 1 and 3; and Zone 3, which includes the eastern portion of the watershed containing the waste disposal areas, is restricted to DOE/NNSA-controlled industrial use. Subsequent to the Phase I ROD, NNSA has determined that all of Bear Creek Valley should remain under DOE/NNSA-control for potential future use in support of the Y-12 mission. Since current plans do not call for release of Zones 1 and 2 from DOE/NNSA control, remediation of Bear Creek surface water to levels suitable for residential or recreational use may be unnecessary under an RBES remedy. However, the Phase I source reduction actions are largely completed, such that reconsideration of this decision would offer little benefit.

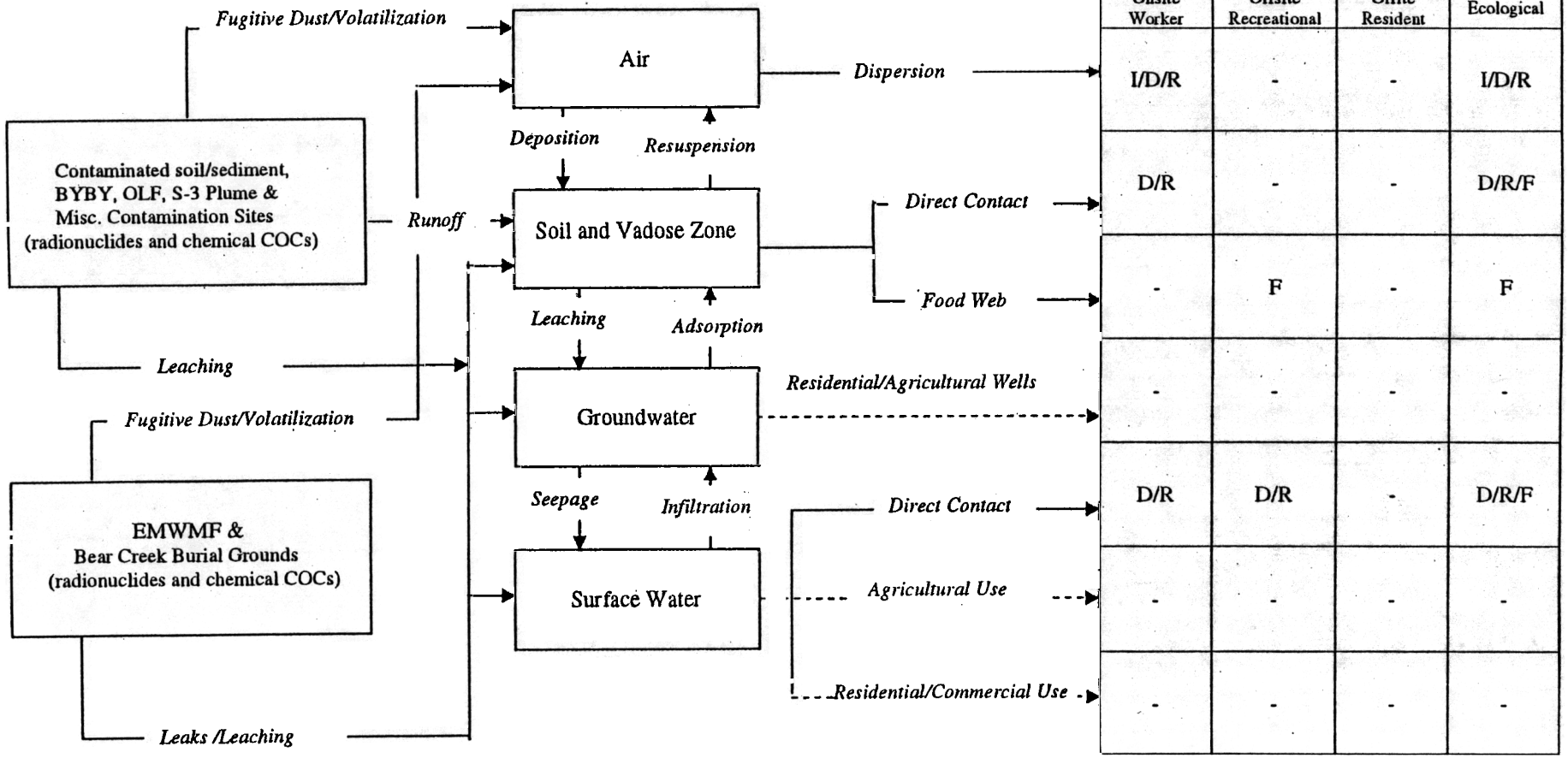
Maps of the Bear Creek Valley watershed under current and RBES conditions are provided in Figures 4.5a1 and 4.5.b1. Conceptual site models under current state and RBES conditions are illustrated in Figures 4.5a2 and 4.5b2, respectively.

The RBES scenario for Bear Creek Valley is considered to be identical to the current baseline. Primary source areas at the Boneyard/Burnyard have already been removed and/or contained. Disposed wastes at the EMWMF and Bear Creek Burial Ground will require active surveillance and maintenance programs to ensure the long-term integrity of cover systems; while the final cover systems will be designed to minimize requirements for active care, periodic maintenance may be required to minimize the potential for failure. Groundwater monitoring wells will require periodic maintenance and replacement at longer (assumed ~30 years) intervals. A long-term stewardship program will ensure the continuing protectiveness of the remedy, including continuing surveillance and maintenance. Since contaminants will remain on site above levels suitable for unlimited use and unrestricted exposure, a statutory review will be conduct at least every five years to ensure that the remedy continues to be protective of human health and the environment.

*[Insert Figure 4.5.a1 – Hazard Area 5 (Bear Creek Valley) Map – Current State]*

*[Insert Figure 4.5.b1 – Hazard Area 5 (Bear Creek Valley) Map – RBES*

*Figure 4.5a2, Conceptual Site Model - Hazard Area 5, Bear Creek Valley – Current State*




| Potential Receptor Exposed | | | |
|---|---|---|---|
| Onsite Worker | Offsite Recreational | Offite Resident | Ecological |
| I/D/R | - | - | I/D/R |
| D/R | - | - | D/R/F |
| - | F | - | F |
| - | - | - | - |
| D/R | D/R | - | D/R/F |
| - | - | - | - |
| - | - | - | - |

**KEY**

→ Active transport, uptake, or exposure pathway

⇢ Blocked or mitigated transport, uptake, or exposure pathway

I – Inhalation
D – Dermal contact R – Direct Radiation Exposure
F – Ingestion

*Figure 4.5a2, Conceptual Site Model - Hazard Area 5, Bear Creek Valley – Current State*

**Narrative:**

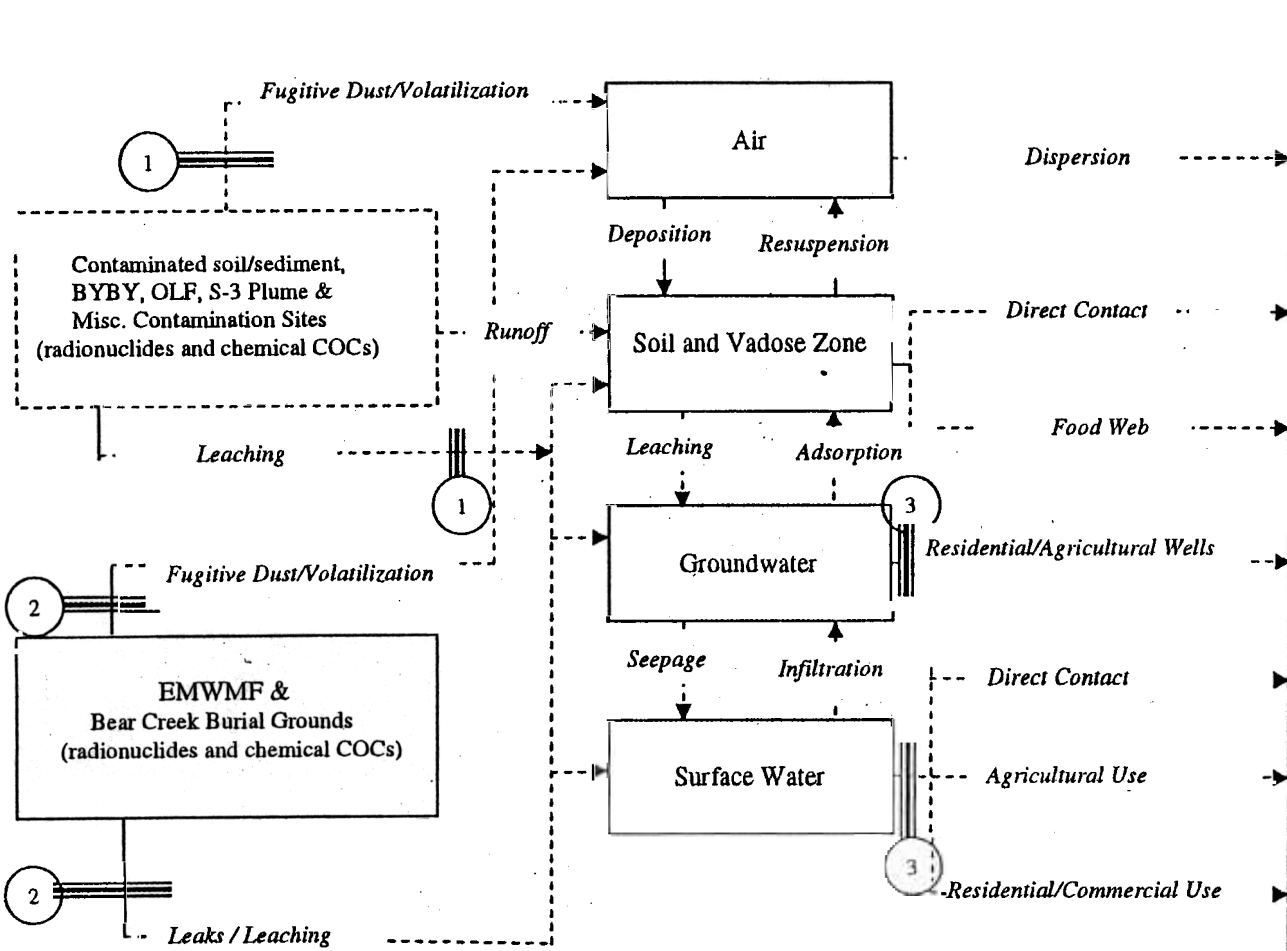
**Contaminant Sources:**

Bear Creek Valley contains several of the major waste disposal sites within the ORR, which constitute the primary hazards and contaminant sources within this hazard area. The Environmental Management Waste Management Facility (EMWMF) was constructed specifically for disposal of CERCLA waste from throughout the ORR meeting waste acceptance criteria; construction and operation of this facility was performed in accordance with a CERCLA Record of Decision. EMWMF will be the permanent repository for the great majority of remediation wastes generated within the ORR. The Bear Creek Burial Grounds (BCBG) were used for disposal of large volumes of uranium wastes generated from Y-12 operations and throughout the ORR. No remediation decision has been made regarding the BCBG. Other contaminant sources within Bear Creek Valley which were addressed under the Phase I ROD include the Boneyard/Burnyard, the Oil Landfarm Area and the S-3 Site Plume. Remediation of these sources under Phase I actions was designed to significantly reduce the flux of uranium, nitrates, and other contaminants to Bear Creek surface water, with the intent to achieve a risk target to a hypothetical downstream receptor. Phase I actions included specific source removal actions, but did not include development of specific remediation criteria for soils or other media. The Phase I ROD subdivided the Bear Creek Valley into three Zones each with a different potential end use; however, DOE/NNSA has since determined that all of this property should remain under DOE/NNSA control for the foreseeable future in support of the Y-12 mission. Contaminants of concern include radionuclides (primarily uranium), nitrate, metals (Hg), VOCs, and PCBs.

**Current State Exposure Pathways and Receptors:**

Under current conditions, potentially complete exposure pathways for onsite workers include: inhalation of resuspended particulates or volatiles; and direct exposure to contaminants in soils, waste and surface water. While Bear Creek Valley is not normally accessible to recreational users, potentially complete exposure pathways to off-site recreationists include direct contract with surface water and ingestion of fish. Ecological receptors potentially may be exposed to contaminants in air, soil, surface water and the food chain. No potentially complete exposure pathways to offsite residents have been identified. There is no current use of groundwater or surface water at Bear Creek Valley for residential, commercial, or agricultural purposes.

*Figure 4.5b2, Conceptual Site Model – Hazard Area 5, Bear Creek Valley – RBES*




| Potential Receptor Exposed | | | |
|---|---|---|---|
| Onsite Worker | Offsite Recreational | Offite Resident | Ecological |
| I/D/R | - | - | I/D/R |
| D/R | - | - | D/R/F |
| - | F | - | F |
| - | - | - | - |
| D/R | D/R | - | D/R/F |
| - | - | - | - |
| - | - | - | - |

**KEY**

Active transport, uptake, or exposure pathway

Blocked or mitigated transport, uptake, or exposure pathway

Engineered barrier or administrative control – sequentially numbered

I – Inhalation
D – Dermal contact R – Direct Radiation Exposure
F – Ingestion

*Figure 4.5b2, Conceptual Site Model – Hazard Area 5, Bear Creek Valley – RBES*

**Narrative:**

**Contaminant Sources:**

Under both current life-cycle baseline and Risk-Based End State conditions, Bear Creek Valley will remain under DOE/NNSA control for the foreseeable future. This area, located immediately west of the Y-12 main industrial complex, is laregely undeveloped and has been used historically primarily for waste management operations. Numerous waste management facilties within this area previously have been closed-in-place under RCRA regulations, and will require institutional controls in perpetuity. The most important waste disposal facilities expected to remain within Bear Creek Valley include the Bear Creek Burial Grounds and the EMWMF.

Remediation criteria for contaminants of concern in soil and other media have yet to be determined, but it is expected that such criteria will be risk-based and that any residual contamination below these criteria that will remain in soils, sediments, surface water and groundwater will not pose an unacceptable risk to future DOE/NNSA industrial workers. Institional controls will include restrictions on future groundwater use.



**Risk-Based End State Barriers/Interventions:**

The steps taken to mitigate or remove these hazards are as follows:

1. Primary source material (contaminated soil and wastes) at the Boneyard/Burnyard has been excavated and disposed at the EMWMF; this site was determined to be the greatest contributor to uranium flux to Bear Creek. Other less highly contaminated materials at the Boneyard/Burnyard were consolidated in place beneath a soil cover. One of the three primary components of the S-3 Ponds Site plume also was addressed under the Phase I ROD. Other contaminant source areas, not addressed in the Phase I ROD, which remain within Bear Creek Valley include the remaining portions of the Oil Landfarm Area, Bear Creek Burial Grounds, and the S-3 Ponds Site pathways 1 and 2. These areas will be addressed in future decisions, but it is likely that remedial actions will continue to be focused on reducing the potential for offsite migration of contaminants in the surface water of Bear Creek.

2. Major waste disposal areas, including the Bear Creek Burial Grounds and the EMWMF, are expected to remain at their present locations, dedicated to permanent waste management. Most portions of the BCBG have been previously closed-in-place under RCRA, with multi-layer caps currently in place. The EMWMF also will be closed-in-place with a multi-layer cover system upon completion of its operational life-cycle. In each case, the engineered containment systems will preclude unacceptable exposures to workers or releases of contaminants to the environment above levels of concern.

3. Future land use within Bear Creek Valley will be restricted to DOE/NNSA controlled industrial use, with emphasis on permanent waste disposal operations and prohibitions on groundwater and surface water use. Long-term stewardship and institutional controls will ensure continuing protectiveness of the remedy. Surveillance and maintenance will include monitoring of surface water and groundwater, with periodic maintenance and replacement of groundwater wells and ongoing maintenance of capped areas as required.

### *4.6 Hazard Area 6 - Chestnut Ridge*

The Chestnut Ridge watershed consists of approximately 2000 acres immediately south of the main industrial area of the Y-12 National Security Complex and bounded to the north by Bethel Valley Road. This area consists of several distinct subwatersheds, each draining south into the Clinch River.

Chestnut Ridge contains a number of waste disposal sites, including hazardous waste sites regulated under RCRA and/or CERCLA, as well as industrial landfills permitted by the TDEC. Several of these facilities have been previously closed under RCRA regulations, while others continue to be actively operated.

Remedial action planning for the Chestnut Ridge watershed is in a relatively early stage. A CERCLA Record of Decision is expected to be completed in FY 2009.

Current State Chestnut Ridge:

Contaminant sources and facilities in Chestnut Ridge include the following:

- RCRA-regulated solid waste management units include the East Chestnut Ridge Waste Pile, and the Contaminated Soils Storage Area and Storm Sewer Sediment Drying Facility; contaminants of concern at these sites include mercury, uranium, and PCBs.
- RCRA/CERCLA-integrated units include the Chestnut Ridge Security Pits, Kerr Hollow Quarry, and the Chestnut Ridge Sediment Disposal Basin. Contaminants of concern include cadmium, chromium, lead, nickel, mercury, uranium, carbon tetrachloride, and chloroform.
- Industrial landfills permitted under TDEC solid waste regulations include three Class 2 (industrial) landfills, designated Landfill II (closed), IV, and V; and two Class 4 (construction/ demolition) landfills, designated Landfill VI and VII.
- Additional non-RCRA-regulated sites to be addressed under the CERCLA program include the United Nuclear Corporation site, the Filled Coal Ash Pond, Rogers Quarry, the Chestnut Ridge Borrow Area Waste Pile, the Mercury-Contaminated Gully Soil Pile, the Criticality Testing Facility, and the Uranium Oxide Vaults. These sites contain a variety of contaminants of concern, including nitrates, arsenic, copper, lead, zinc, mercury, uranium and fly ash.

Life-Cycle Baseline Plan for Chestnut Ridge:

Under the current baseline, no near-term opportunities for major risk reduction at Chestnut Ridge have been identified. Other remedial actions are in relatively early stages of planning, but the overall remediation program is scheduled for completion by 2015:

- While the remedy at Chestnut Ridge is in a preliminary planning stage, potential remedial actions include a combination of excavation and disposal or closure-in-place of buried

materials that pose an unacceptable risk to the environment. Institutional controls will be maintained under a long-term stewardship program to control future land use, to restrict access to capped waste disposal areas, and to prohibit onsite use of groundwater, as necessary for protection of human health and the environment.

Risk-Based End State Vision for Chestnut Ridge:

Current baseline plans for Chestnut Ridge include cleanup actions designed to support the planned industrial end use of the site, and provide an acceptably low level of risk to future DOE/NNSA workers. Remediation criteria are expected to be risk-based and specific to the planned end use of the site. However, remediation planning for this hazard area is not sufficiently developed to permit a meaningful analysis of potential variances.

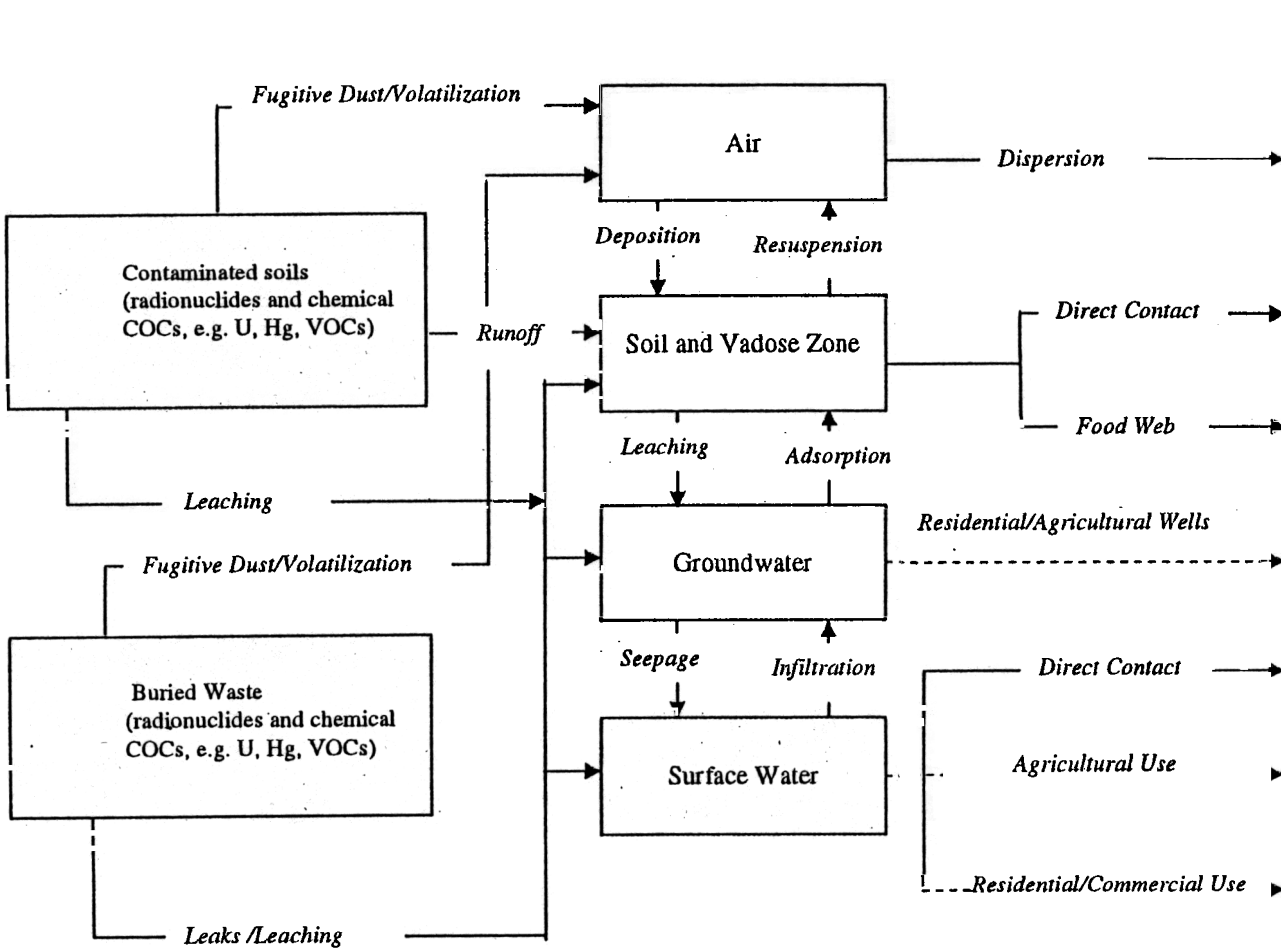
Maps of the Chestnut Ridge watershed under current and RBES conditions are provided in Figures 4.6a1 and 4.6.b1. Conceptual site models under current state and RBES conditions are illustrated in Figures 4.6a2 and 4.6b2, respectively.

The current baseline and RBES scenarios for Chestnut Ridge remedial actions are considered to be identical. However, remedial action planning for this area is at a very preliminary stage. Some of the waste management facilities in Chestnut Ridge previously have been closed in place under RCRA, and it is assumed that most areas of buried wastes generally will be managed in place through capping. The containment system for capped areas will require periodic maintenance and repair to minimize the potential for failure. Groundwater monitoring wells will require periodic maintenance and replacement at longer (assumed ~30-year) intervals. A long-term stewardship program will ensure the continuing protectiveness of the remedy, including continuing surveillance and maintenance. Since contaminants will remain on site above levels suitable for unlimited use and unrestricted exposure, a statutory review will be conduct at least every five years to ensure that the remedy continues to be protective of human health and the environment.

*[Insert Figure 4.6.a1 – Hazard Area 6 (Chestnut Ridge) Map – Current State]*

*[Insert Figure 4.6.b1 – Hazard Area 6 (Chestnut Ridge) Map – RBES]*

*Figure 4.6a2, Conceptual Site Model - Hazard Area 6, Chestnut Ridge – Current State*




| Potential Receptor Exposed | | | |
|---|---|---|---|
| Onsite Worker | Offsite Recreational | Offite Resident | Ecological |
| I/D/R | - | - | I/D/R |
| D/R | - | - | D/R/F |
| - | F | - | F |
| - | - | - | - |
| D/R | D/R | - | D/R/F |
| - | - | - | - |
| - | - | - | |

**KEY**

→ Active transport, uptake, or exposure pathway

- - -▸ Blocked or mitigated transport, uptake, or exposure pathway

I – Inhalation
D – Dermal contact R – Direct Radiation Exposure
F – Ingestion

*Figure 4.6a2, Conceptual Site Model - Hazard Area 6, Chestnut Ridge – Current State*

**Narrative:**

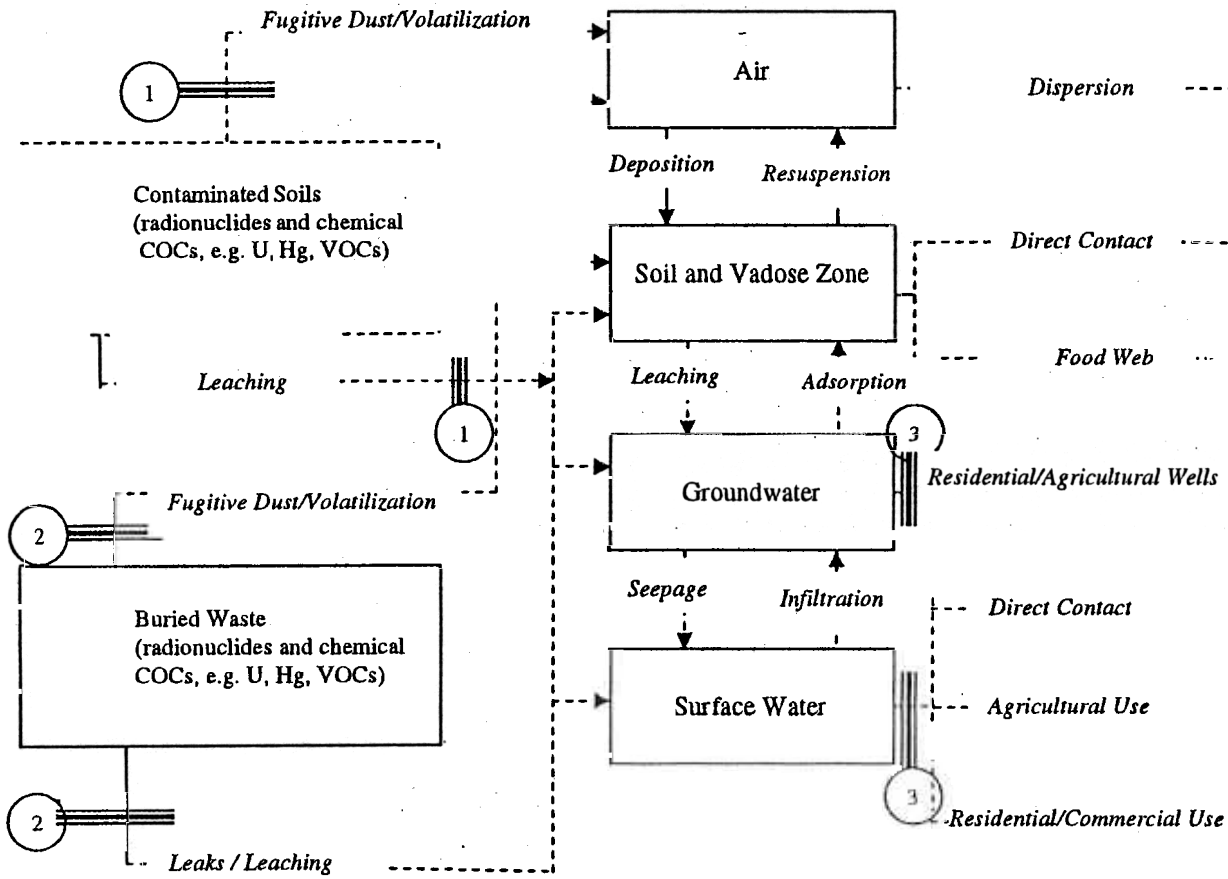
**Contaminant Sources:**

Under current state conditions, primary sources include waste burial sites and landfills, most of which were previously permitted and closed under RCRA regulations and/or state solid waste regulations. Surface and subsurface soils also may contain contaminants of concern in concentrations above site remediation levels (which have yet to be established). Contaminants of concern have not been fully characterized, but are likely to include radionuclides (primarily uranium), metals (Hg), VOCs, and PCBs.

**Current State Exposure Pathways and Receptors:**

Under current conditions, potentially complete exposure pathways for onsite workers include: inhalation of particulates or volatiles; and direct exposure to radiation in soils, waste and surface water. Potentially complete exposure pathways to off-site recreationists include direct contract with surface water and ingestion of fish. Ecological receptors potentially may be exposed to contaminants in air, soil, surface water and the food chain. No potentially complete exposure pathways to offsite residents have been identified. There is no current use of groundwater or surface water at Chestnut Ridge for residential, commercial, or agricultural purposes.

*Figure 4.6b2, Conceptual Site Model – Hazard Area 6, Chestnut Ridge – RBES*




| Potential Receptor Exposed | | | |
|---|---|---|---|
| Onsite Worker | Offsite Recreational | Offite Resident | Ecological |
| I/D/R | - | - | I/D/R |
| D/R | - | - | D/R/F |
| - | F | - | F |
| - | - | - | - |
| D/R | D/R | - | D/R/F |
| - | - | - | - |
| - | - | - | - |

**KEY**

Active transport, uptake, or exposure pathway

Blocked or mitigated transport, uptake, or exposure pathway

Engineered barrier or administrative control – sequentially numbered

I – Inhalation

D – Dermal contact R – Direct Radiation Exposure

F – Ingestion

*Figure 4.6b2, Conceptual Site Model – Hazard Area 6, Chestnut Ridge – RBES*

**Narrative:**

**Contaminant Sources:**

Characterization and remediation planning for Chestnut Ridge is at the earliest stage of any area within the ORR. Under both current life-cycle baseline and Risk-Based End State conditions, this area will remain under DOE/NNSA control. This area, located immediately south from the Y-12 main industrial complex, is relatively undeveloped and has been used historically primarily for waste management, with a number of solid waste landfills and classified waste disposal sites. No specific needs for future development of this area have been identified, and it is likely to remain relatively undeveloped and serve a primary function as a buffer area around the Y-12 National Security Complex. Most of the existing landfills and waste burial sites have been or are expected to be closed-in-place, and will require institutional controls in perpetuity. Remediation criteria for contaminants of concern in soil and other media have yet to be determined, but it is expected that such criteria will be risk-based and that any residual contamination below these criteria that will remain in soils, sediments, surface water and groundwater will not pose an unacceptable risk to future DOE/NNSA industrial workers. Institional controls will include restrictions on future groundwater use.

**Risk-Based End State Barriers/Interventions:**

The steps taken to mitigate or remove these hazards are as follows:

1. Contaminated soils containing contaminants of concern above (yet to be determined) remediation criteria will be removed for offiste disposal. Residual contaminant levels will be below levels of concern for fugitive dust emissions or direct radiation exposure.

2. Waste burial areas and landfills will be closed-in-place via capping. Some facilities have previously been closed-in-place under RCRA, with multi-layer caps currently in place. Alternatively, some wastes may be excavated for disposal at the EMWMF disposal facility in adjacent Bear Creek Valley, particularly if RCRA post-closure monitoring indicates inadequate performance of contaminment systems. Residual contamination levels will be below levels of concern for direct radiation exposure or fugitive dust emissions/volatilization.

3. Future land use is restricted to industrial use, with prohibitions on groundwater and surface water use. Long-term stewardship and institutional controls will ensure continuing protectiveness of the remedy. Surveillance and maintenance will include monitoring of surface water and groundwater, with periodic maintenance and replacement of groundwater wells and ongoing maintenance of capped areas as required.

## 5.0 REFERENCES


BWXT Y-12 LLC, 2003, *Y-12 National Security Complex Ten-Year Comprehensive Site Plan FY2004-FY2013*, Y/MOD-012 Rev. 3, August 2003.

Department of Energy, 1992, *Interim Record of Decision for the Oak Ridge National Laboratory, Waste Area Grouping 11, Surface Debris* .

Department of Energy, 1997a, *Remedial Investigation Report for the Melton Valley Watershed at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-1546&D2.

Department of Energy, 1997b, *Report on the Remedial Investigation of Bear Creek Valley at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee*, DOE/OR/01-1455/V1&D2.

Department of Energy. 1998. *Comprehensive Integrated Planning: A Process for the Oak Ridge Reservation.* May 1998.

Department of Energy, 1998a, *Report on the Remedial Investigation of the Upper East Fork Poplar Creek Characterization Area at the Oak Ridge Y-12 Plant*, DOE/OR/01-1641/V1-V4&D2.

Department of Energy, 1998b, *Characterization Report for the BCV Boneyard/Burnyard Accelerated Action Project for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee*, BJC/OR-113.

Department of Energy, 1999a, *Remedial Investigation Report/Feasibility Study for Bethel Valley Watershed at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-1748&D2.

Department of Energy, 1999b, *Record of Decision for the Disposal of Oak Ridge Reservation Comprehensive Environmental Response, Compensation, and Liability Act of 1980 Waste* , DOE/OR/01-1791&D3, November 1999.

Department of Energy, 2000, *Record of Decision for Interim Actions for the Melton Valley Watershed at the Oak Ridge National Laboratory, Oak Ridge, Tennessee,* DOE/OR/01-1826&D3, September 2000

Department of Energy, 2001a, *Final Site-Wide Environmental Impact Statement for the Y-12 National Security Complex*, DOE/EIS-0309, September 2001.

Department of Energy, 2001b, *Record of Decision for Phase I Activities in Bear Creek Valley,* DOE/OR/01-1750&D2, September 2001.

Department of Energy. 2002. *A Review of the Environmental Management Program.* February 2002.

Department of Energy, 2002a, *Record of Decision for Interim Actions in Zone 1, East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-1997&D2, October 2002.

Department of Energy, 2002b, *Record of Decision for Interim Actions Bethel Valley,* DOE/OR/01-1862&D4, May 2002.

Department of Energy, 2002c, *Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area*

Department of Energy. 2003a. *Use of Risk-Based End States.* Policy DOE P 455.1. July 7, 2003.

Department of Energy. 2003b.*Guidance for Developing a Site-Specific Risk-Based End State Vision.* September 11, 2003.

Department of Energy, 2003c, *Explanation of Significant Differences for the Record of Decision for Interim Actions for the Melton Valley Watershed,* 2003

Department of Energy, 2003d, *Upper East Fork Poplar Creek Soil Focused Feasibility Study* , July 2003.

End Use Working Group. 1998. *Final Report of the Oak Ridge Reservation End Use Working Group*. July 1998.
Lockheed Martin Energy Research Corporation (LMER), 1999, *Oak Ridge National Land and Facilities Plan*, ORNL/M-6714, prepared for the U.S. Department of Energy, Oak Ridge Operations Office, Oak Ridge, Tennessee, August 1999.
U.S. Bureau of the Census, 1992, *Census of Population and Housing, 1990: Summary Tape File 3* (CD-ROM), U.S. Department of Commerce, Economics, and Statistical Administration, Washington, DC.
U.S. Bureau of the Census, 2004, *Your Gateway to Census 2000; Population, Housing Units, Area, and Density: 2000, Census 2000 Summary File 1 (SF 1) 100-Percent Data*, U.S. Department of Commerce, Economics, and Statistical Administration, Washington, DC, http://factfinder.census.gov.
U.S. Bureau of Economic Analysis (BEA), 1999, *REIS: Regional Economic Information System 1969-1997* (CD-ROM), U.S. Department of Commerce, Economics, and Statistics Division, Bureau of Economic Analysis, Washington, DC.
UT-Battelle LLC, 2002, *Oak Ridge National Laboratory Land and Facilities Plan*, ORNL/TM-2002/1, August 2002.

# APPENDIX A. VARIANCE ANALYSIS

Table A-1 summarizes proposed variances between the current life-cycle baseline plan for the DOE-ORO Environmental Management program for the Oak Ridge Reservation (ORR) and the risk-based end state (RBES) vision for the ORR. Table A-1 provides a brief description of each proposed variance, potential impacts of the variance, barriers to implementation, and recommendations for action. Maps depicting end state conditions for the ORR under the current baseline and with the variances summarized in Table A-1 are presented in Figures A-1 and A-2, respectively.

# Table A-1. Variance Report for DOE Oak Ridge Reservation Risk-Based End State Vision

| Variance Report | | | | |
|---|---|---|---|---|
| ID No. | **Description of Variance** | **Impacts (in Terms of Scope, Cost, Schedule and Risk)** | **Barriers to Achieving RBES** | **Recommendations** |
| V-1 | ETTP Closure Project, K-1070-B/C/D Burial Grounds - While a final decision will not be made until the ETTP Zone 2 ROD is completed, the current baseline plan calls for the K-1070-B and K-1070-C/D burial grounds to be excavated for disposal at ORR or offsite disposal facilities. This remedy is assumed to be most consistent with the desired end use of the ETTP site as an unrestricted commercial industrial park. However, it may be possible to achieve an equally protective remedy, potentially at lower cost, through capping some or all of these materials in place, particularly for the K-1070-C/D burial grounds. Containment alternatives for K-1070-B would be considered more difficult, as buried waste materials are thought to sit in the saturated zone. Since the K-1070-C/D burial grounds contain classified materials, consideration of security requirements required for implementation of both alternatives must be included in the comparative analysis of alternatives. | No significant impact on schedule is expected. CERCLA decision documents for ETTP Zone 2 are currently under development. All remedial actions at ETTP are scheduled for completion by FY2008.<br>Cost estimates will be developed in the FS currently under development, but cost for capping alternative expected to be less than that for excavation.<br>No unacceptable risk to workers is expected under either alternative, although capping would require long-term institutional controls to ensure protectiveness to future workers. | Capping alternative would be less consistent with the desired end use of the ETTP site as an unrestricted commercial industrial park. The capped burial ground area would require long-term institutional controls to restrict access to and use of this parcel, both to ensure protectiveness of the remedy and to prevent unauthorized access to classified materials. | Continue to evaluate both alternatives in the focused feasibility study currently under development.<br>Coordinate with EPA, TDEC, and other stakeholders through the CERCLA process. |
| V-2 | ETTP Closure Project, Dose-Base Criteria for Building Surface Contamination – The great majority of buildings currently standing at ETTP will be demolished during the site closure process. Only those buildings which have a specific identified future use by private industry will remain, with titles transferred to CROET. These remaining buildings may contain residual radiological contamination on building surfaces (walls, floors, structural beams, etc) that may require decontamination to levels sufficiently protective for future occupants. Current cleanup operations at ETTP are based on surface radioactivity limits specified in DOE Order 5400.5, Table IV-1. Under the RBES, dose-based criteria will be derived specifically for the radionuclides of concern at each building and the designated future use scenarios for that building. These criteria will be derived to limit the potential radiation dose and health risk to future building occupants to levels that are determined to be protective and consistent with DOE policy to reduce exposures as low as reasonably achievable (ALARA). | Use of dose-based criteria, derived for the specific radionuclides of concern and site conditions, would be expected to support more rapid completion of building decontamination and decommissioning (D&D) operations; the time required for development and approval of these dose-based criteria may partially reduce these gains, but the overall schedule impact is expected to be positive. As noted in V-1, all actions at ETTP will be completed by FY2008 in either case.<br>Cost estimates for the use of dose-based surface criteria have yet to be fully developed, but are expected to be lower than costs for use of 5400.5 criteria.<br>No unacceptable risks to future building occupants (workers) would exist under either alternative, but the use of dose- | Dose-based limits must be derived and approved consistent with DOE directives and guidance (DOE 5400.5 and associated guidance, and draft DOE G 441.1-XX), and the remedy must be approved by EPA and TDEC under the CERCLA process. Use of dose-based surface activity limits is entirely consistent with current EPA, NRC, and DOE guidance, so this barrier is anticipated to be primarily administrative and easily resolvable. | Develop appropriate technical documentation for dose-based surface activity criteria for ETTP buildings.<br>Pursue approval of such documentation both within DOE (through the authorized limits process specified in DOE Order 5400.5 and/or the process specified in DOE G 441.1-XX), and also through the CERCLA decision process. |

| Variance Report | | | | |
|---|---|---|---|---|
| **ID No.** | **Description of Variance** | **Impacts (in Terms of Scope, Cost, Schedule and Risk)** | **Barriers to Achieving RBES** | **Recommendations** |
| | | based surface criteria may significantly reduce the risks to remediation workers performing the D&D operations. | | |
| V-3 | Melton Valley Remedial Action Project, Alternative Stabilization Technologies for In-Situ Vitrification - The current baseline plan calls for use of in-situ vitrification (ISV) technology for remediation of buried waste at Trenches 5 and 7 located in the Seepage Pits and Trenches Area of Melton Valley. ISV was selected for use in these areas because these trenches hold a large inventory of radionuclides in a relatively small volume of waste within a small contaminated area. ISV was not proposed for use at other locations within Melton Valley because of the difficulty in using this technology in heterogeneous waste, the potential hazard of using ISV in saturated waste, and the overall high cost of ISV relative to other remediation technologies. Previous demonstration projects using ISV technology at Melton Valley sites near the Trench 5 and 7 area proved unsuccessful. Given the extremely aggressive schedule for Melton Valley remedial actions to be completed by FY2006, other remedial alternatives would achieve an equally protective remedy with less schedule risk and potentially lower cost. Selected remediation measures for adjacent areas already include use of in-situ grouting and capping using a multi-layer cover system. Use of these alternative remediation technologies (in-situ grouting and capping) for the Trench 5 and 7 sites will be protective to human health and the environment under the selected end-state land use for this area (i.e., protection of the worker in this dedicated waste management area). | Construction logic for Melton Valley remedial actions is very difficult due to the highly accelerated schedule for completion of all actions by FY2006. Cost estimates for the capping alternative are currently being developed, but are expected to be less than ISV alternative. No unacceptable risk would be expected under either alternative. Long-term institutional controls will be required under either alternative. | The current CERCLA ROD specifically calls for the use of the ISV technology at Trenches 5 and 7. Deviation from this planned action would require additional CERCLA documentation, such as an Explanation of Significant Differences or ROD Amendment, although the details of such supplemental documentation has yet to be negotiated among the ROD signatories. | Coordinate with EPA, TDEC, and other stakeholders through the CERCLA process. Develop supplemental CERCLA documentation (e.g., Explanation of Significant Differences) as appropriate. |

*[Insert Figure A-1, Site-wide hazard specific map – end state per current baseline.]*

*[Figure A-2, Side-wide hazard specific map – end state including variances.]*